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Focus : Supply Chain Management

SCM—The Concept & Technology

SCM, ERP & the Internet

Competing on e-enabled Supply Chains

Managing Supply Chain Through BPO & HRO

The Mobile Wireless Supply Chain

SCM in Taiwan's Electronic Industry

Excess Capacity in Cement Industry

JIT/TQM Quality Techniques in Indian Industries

Pulse Performance in India

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Contents

Supply Chain Management—The Concept & Technology ... 525
—Ryoichi Watanabe

Introduction to Supply Chain Management ... 531
—R. Mishra, Sachin Lal & Suman Das

SCM, ERP & the Internet ... 535
—Nesa L'abbe Wu

Competing on e-enabled Supply Chains ... 539
—M.L. Singla

Managing Supply Chain Through BPO & HRO ... 546
—Dipak Kumar Bhattacharyya

The Mobile Wireless Supply Chain ... 550
—Hemant Kumar Sabat

Supply Chain Management in Indian FMCG Sector ... 564
—B.S. Sahay & Arun K. Gupta

SCM System in Taiwan's Electronic Industry ... 574
—Han-Lin Li

JIT/TQM Quality Techniques in Indian Industries ... 582
—Vikas Kumar, Dixit Garg & N.P. Mehta

TQM & National Culture: A Contingency Model ... 591
—Naceur Jabnoun & Syed Aziz Anwar

Total Quality Education: A Model for India ... 597
—V. Mariappan

Economics of Engineering Industry in Kerala ... 605
—Ashita Raveendran

Corporate Reporting on Intangibles in India ... 618
—*V.K. Vasal*

Education in Entrepreneurship Development ... 630
—*V. Murugesan & C. Thangamuthu*

Motivational Behaviour: Variation Across Hierarchical Levels ... 636
—*Padmakali Mishra & Gopa Bhardwaj*

Excess Capacity in Cement Industry: Demand/Supply Constraints ... 641
—*K.S. Sujit*

Productivity Growth in Zonal Railways ... 647
—*K.P. Sunny & V. Upadhyay*

Plastic Waste Management Options in India: An Environmental Evaluation ... 659
—*Sabah Khan*

Crop Diversification in Punjab ... 665
—*D.K. Grover, Kamal Vatta & Gurpreet Kaur*

Prioritization of Rice Productivity Constraints ... 669
—*T.R. Shanmugam & N. Venkatesa Palanichamy*

Pulse Performance in India: A Spatial & Temporal Analysis ... 674
—*I. Sekar & Puran Chand*

Virtual Organisation: A Stratagem ... 678
—*Zillur Rahman*

News & Notes ... 688

Book Reviews ... 692

Supply Chain Management—The Concept & Technology

Ryoichi Watanabe

SCM smoothens the material flow in all operations of industries and results in resource optimization. The article elaborates on the concept and methodology of SCM as practised in leading global industries.

Ryoichi Watanabe is Senior consultant, SAP Japan.
Paper presented at 9-11 January, 2001, Sponsored by APO & NPC.

Global business scenario has undergone drastic changes in the past decade. The environment wherein manufacturing industries operate has been so transformed that some of the old generation companies have lost business and are struggling hard to survive. Changes have occurred in many areas.

Recent Changes in Business Scenario

More companies (especially from Asia) have joined global competition by participating in the international market which was formerly dominated by US and some west European companies. As a result competition has become very tough. Customers have become more sophisticated and demanding as there are more choices. Hence, products need to be lower in cost, higher in quality, delivered on time and adjustable (customizable) to the customer's taste. The product life cycle has become very short due to rapid changes in the market situation. The period during which the manufacturer can enjoy profit from the new product has become very short and designs have to be constantly revised. The global trend of economy has shifted from inflation in 70's to deflation in the '90s. The market is shrinking which means that carrying a big inventory becomes very risky. Stockholders look for higher returns on their investment (ROI) and companies whose ROI is not high enough can not attract enough capital for future investments. The most powerful impact on today's business has been due to the IT (Information Technology) Revolution. The rapid progress in Information Technology has changed the whole scenario and brought in new players. New companies who utilize the latest Information Technology can now jump into an existing market and gain a big market share in a very short time (example; Amazon.com). Information Technology (IT) has caused huge business paradigm changes in various industries.

These changes have had a very strong impact on

old generation companies and some of them have gone out of business while others have metamorphosed themselves to adjust to the new environment. The successful companies have achieved customer satisfaction, shorter product development lead-time, lower inventory level and procurement cost, agile and flexible manufacturing through SCM. With SCM activities companies can improve profitability in a quantum jump by focusing on the operations across companies in a whole supply chain rather than struggling within a single company.

Companies have achieved customer satisfaction, shorter product development lead-time, lower inventory level and procurement cost, agile and flexible manufacturing through SCM.

SCM in manufacturing industries: The History

In the manufacturing community, productivity improvement has always been the biggest issue. Ever since its introduction, computer has come to be widely used in commercial industries with IT providing various solutions to the never-ending pursuit of productivity improvement. About 30 years ago, MRP (Material Requirement Planning) was introduced to the business world. This was the first computer aided planning system to support manufacturing and was very widely adopted throughout the world by manufacturing industries, as the use of computer became popular. Bill of Material (BOM), which were earlier on paper or drawings, were digitalized and stored in the computer to calculate the required quantity of materials to fulfill the production plan of final goods. After MRP became popular, there were several innovations and the method was improved step by step and practised under changing names, such as MRP II (Manufacturing Resource Planning), CIM (Computer Integrated Manufacturing), ERP (Enterprise Resource Planning), etc. These advances were possible mostly due to improvement of the computing power of the hardware and the vast strides in Information Technology.

In MRP II manufacturing capacity was included in production planning so that excess amount of parts procurement, (which can happen under MRP with a very big production planning regardless to the capacity), can be avoided. CIM was the idea to combine production system with sales. Before that, sales and production departments operated as separate systems with weekly or monthly batch data transfer. By synchronizing the sales and production systems by daily batch data transfer or in a centralized computer, change in sales volume can be immediately reflected on the production planning. This innovation proved essential to cope with fluctuating market volumes. ERP came next. ERP is the business software package which covers all the basic business processes of the manufacturing companies in the unified environment. The business areas covered by ERP are Financial accounting, Accounting, Sales, Material Management, Purchasing, Production Planning, Human Resource Management, etc. And all of these business applications could be realized in a smaller computer (UNIX machine or Windows NT machine) compared to the huge IBM mainframe computes of 1980's. The additional advantage was that customers could easily customize the system to adjust it to their own company's business practice. The various commonly used business practices are already built in the system and users can select them by simply setting the parameters; no program coding is required usually for customizing. ERP made the information flow within the company real time. The data across department in a company now became transparent. This caused supply chain within a company simple and efficient.

So far, all of these methods focused on the problems within a single plant or company. After the manufacturing industries did everything they can to improve the efficiency of operations in their own companies, they realized that big inefficiencies still existed between the borders in a Supply Chain. Suppliers, vendors and other plants had been out of the focus of the problem solution horizon. But recently, manufacturers have started viewing the production planning, distribution, transportation and optimization processes also as part of the Total Supply Chain. As customers become increasingly sophisticated and aware, they demand customised products at the right place at the right time – otherwise they purchase elsewhere. Manufacturers who can satisfy this need gain the market-share and those who can't are losers. SCM has been evolved under such circumstances as the solution to improve the productivity of the total supply chain beyond the company borders.

SCM has been evolved as the solution to improve the productivity of the total supply chain beyond the company borders.

The competitive advantage of supply chain is now in managing the flow of materials and products through the entire supply chain. SCM application represents a model of how an organisation's production and distribution networks work together to satisfy customer demands. Main goals of SCM are:

- On-time delivery for improved CS (Customer Satisfaction)
- Increased throughput of the entire supply chain (not of a single plant)
- Reduced cycle times
- Minimized costs
- Centralized planning and Distributed Execution

There are several SCM software packages available in the market, and they are drawing attention from manufacturing industries. Some companies who have implemented SCM have been very successful in improving their total productivity and have increased the profit margin dramatically. As the use of the Internet is becoming popular, the trend to look beyond one's company has accelerated. By exchanging information easily via the Internet, several companies can now work together to form a total supply chain. The idea of virtual company has become a ground reality. Small venture companies whose strength is in marketing can work together with some other small companies having competence in manufacturing, sales, distribution, etc. Internet technology has also changed the conventional business model. A good example is amazon.com. Retail bookshops are no more needed to sell books to end consumers. Business to Business (B2B) e-Procurement is becoming the hottest issue improving the efficiency of purchasing department and reducing inventory. Internet and e-commerce are essential parts of SCM system implementation.

SCM components and technologies

SCM system possesses the following capabilities:

- Flow of information is easy, fast and accurate among the supply chain network elements (Plants, Suppliers, Distribution Centers, Customers, etc)

Flow of information is easy, fast and accurate among the supply chain network elements

- Information immediately triggers the corresponding product transition
- Self-regulation principles operate for all network elements
- There is integration of demand and fulfillment processes
- Internet capability is an essential ingredient

The functional tools of SCM systems are as follows:

Demand Management/Forecasting: A toolbox equipped with all kinds of statistical forecasting techniques, the purpose being to provide accurate forecasts.

Advanced Planning and Scheduling: A planning tool to create tactical, mid to long term plans and sourcing decisions that takes the complete supply network into consideration.

Transportation Management: A function to provide optimum and executable truck loading plan for distributing the product to supply chain.

Distribution and Deployment: A planning tool to rebalance and optimize the distribution network at execution time. Here VMI (Vendor Managed Inventory) is taken into account for optimization.

Production Planning: Production Planning and shop floor scheduling using dynamic pegging and optimization techniques.

Available-To-Promise: A quick responding material availability check that considers allocations, production, transportation capacities and costs in the total supply chain network.

Supply Chain Modeler: An easy-to-use graphical tool for modeling, navigating and controlling the supply chain network. Alert monitor function to detect exceptional condition in the total supply chain network is usually provided.

Optimizer

The optimizer is the heart of SCM system. It includes Linear & Integer Programming, non-linear programming, heuristics and genetic algorithm. Genetic algorithm is a computing technology for searching the best solution among the millions of possible combination of parameters. By mimicking heredity of animals, the algorithm creates the next generation candidates (children) by combining some of the best candidates of the current generation (parent). If we go through several generations by dropping the unwanted candidates and keeping only good candidates we reach the best (or nearly the best) candidate much sooner than searching exhaustively in the solution space. Production scheduling is one of the fields to where genetic algorithm is practically applied.

A methodology called Constraint Programming

and/or Theory of Constraints (TOC, by Dr. Goldratt) are also adopted by SCM. These technologies have been theoretically available for more than ten years. But they needed to wait for the strong computational power, which made them practically useful in the real business world in recent years.

Theory of Constraints (TOC)

TOC is often explained by using a metaphor of picnic of children. Here is the story.A group of children were on a picnic walking to a certain destination for lunch. In this group there were some children who can walk faster than others, while a boy was the slowest. There was an adult leader to take care of the children and take them to the destination before lunch. In the beginning, the leader let the children walk as they liked, then he realized that he could not take care of all the children because the group of faster children went ahead of others and the slowest boy was left far behind. Soon, the gap was increased to an uncontrollable distance. The leader also realized that they could not arrive at the destination before lunch with the current speed of walking. So he decided to let the children walk in a line with an order that one must always follow the child in front of him, and must not pass and go ahead of him. He put the slowest boy in the center of the line. There again appeared a big gap in front of the slowest boy, while the line after him was kept in order. But, the total walking speed of the entire group was same as before. Then the leader noticed the slowest boy was carrying a heavy bag. He divided the contents of the bag into several small portions and let the faster children carry them. Finally the walking speed of the slowest boy was increased, and the speed of the entire group became faster than before. They could finally get to the destination by lunch time.

A similar situation exists in a manufacturing plant with many different type of machines where materials are moving from one machine to the other until the final goods come out at the end of the production line. If we replace the children by machines and the walking speed of each child by the processing speed of each machine in the metaphor, the lead time required to arrive at the destination for the children is the lead time required to produce the final goods from the input material to the plant and the gap before the slowest boy is the pile of work-in-process materials in front of the slowest machine. The slow machine is the bottleneck of the entire plant and productivity can not be improved unless the speed of the slowest machine is increased. Increase in process speed of the machines before the bottleneck leads to a big pile of semi-finished goods in front of the bottleneck. And speed increase of machines after the bottleneck only increases the waiting time of these machines.

By extracting a generic rule out of this story, Dr. Goldratt describes in his famous novel 'The Goal', we need to follow the following five steps to improve productivity.

- Identify the System's constraints (or bottleneck)
- Decide how to exploit the system's constraints
- Subordinate everything else to the above decision
- Elevate the system's constraints
- If in the previous steps the constraint is broken, go back to step 1

We need to reconsider what 'Productivity' really means. The traditional meaning of 'Productivity' is to produce something at a low cost with high speed. The product cost is usually calculated based on the procurement cost of the input material plus the machine and labor cost added in the plant. Let's look at the machine cost here. The unit machine cost can be reduced if we can increase the utilization of the machine. So the plant managers always try to maximize the machine utilization in the plant. To do so, they sometimes produce some goods beyond the customers' demand level because the performance of the plant manager is often evaluated by the utilization level of the machines in the plant which

The traditional meaning of 'Productivity' is to produce something at a low cost with high speed.

is the traditional interpretation of 'Productivity'. But if the plant produces something, which can not be sold to customers, the plant loses money. The plant needs to pay for the procured materials and no money comes in; there is only the piles of the final products remaining unsold in the storage area. The best way to improve the cash flow of the plant, which is the real 'Productivity'. is to produce goods only as much as customers buy. No more and no less, ideally. If this can be achieved, the productivity of the company (e.g. ROI) increases. If there is some capacity left in the plant, the first effort should be to try to sell more so that the plant need to

The cash flow of the plant is the real 'Productivity'.

produce more, and refrain from producing more without sales prospects. There are some APSs (Advanced Planning System) in the available SCM packages which calculate optimum production level based on various constraints, such as production resource capacity, material supply capacity and sales capacity.

Internet and e-Commerce

Internet and web technology are the hottest topics in SCM lately. The business community has realized now that Internet is a very useful tool for communication. People connected via Internet now send more e-mails in a day than phone calls or physical mails. e-mail is a very good media for communication for individuals. When it is extended to industries, business use of Internet is e-commerce. Here the communication is between a company and consumers i.e. Business to Consumer or B2C. Front runners of this B2C area are 'Amazon.com' and 'Dell'. Both these companies changed the business model by fully utilizing the power of Internet in business.

Amazon.com is the famous online bookshop, which has grown very rapidly in the last couple of years. Customers can order books from the PC in their home at the Amazon.com home page. They can search for special books from the very large list, millions of titles stored in the computer catalog and place an order. Then a couple of days later, the books are delivered at home. A credit card is used for the payment. On the other hand, if the customer chooses to go to the bookshop in the town the chances of finding the special books are very limited. The supply chain to support this business model of Amazon.com is much simpler than the ones of traditional bookshops. Amazon.com needs to have some large regional distribution center where they keep inventories. And the home delivery service companies deliver the books directly to the customer. By replacing the physical retail shops by the Internet homepage they could reduce the total inventory cost of books carried in the retail shop, they could eliminate the investment cost for building the retail shops in every town in the country and they could grow so rapidly because they could reach customers all round the world instantaneously.

Dell, a PC manufacturer was following Compaq and IBM and other PC makers when Mr. Dell decided to go in for direct sales of their PC via the Internet. At that time other PC makers were selling their products in retail shops. In the retail shops customers usually buy PCs which are pre-assembled, packed in a box and stored in a small storage area of the shop. It is very difficult for the customer to find exactly what they need out of the limited inventory of the retail shop. On the other hand, Dell started to sell their customised PC via Internet directly to the customers. In the homepage of Dell, a customer can select the various kinds of options (such as memory, hard disk, other drives, keyboard, display etc) to configure his/her PC exactly as wanted. Dell does not maintain stocks of fully assembled PCs; all PC components are stocked in the large distribution center so that they can be assembled and shipped to the customer immediately after the customer order arrives. All of this has become possible because of the Internet and other IT technologies such as ERP which enable real time communication between Web sales system, shipment, manufacturing and purchasing system. Configure to order manufacturing is enabled under such integrated infrastructure.

By replacing the physical retail shops by the Internet homepage they could reduce the total inventory cost.

So far, the early successes of e-commerce have been mostly in B2C area. They have contributed a great deal to the retail market by creating a completely new business model. Now, in terms of the size of economy, the amount traded between companies is much bigger than the amount traded by the end consumers. So, it is believed that the next big wave of e-commerce would come in the Business to Business (B2B) area. There are several areas where Internet can play a big role in B2B, such as in Maintenance, Repair and Operation, Direct material purchasing, e-market place etc.

Maintenance Repair and Operation (MRO): This is an ad-hoc purchasing of plant maintenance parts or office supplies such as notebooks and PCs. In MRO purchasing, the purchase requirement usually comes from manual interactions of a human operator who is actually requesting the purchase. It is a day to day purchasing, but it is not in a big lot like direct material purchasing for production. Earlier, those who needed some goods in the office or plant, submitted the purchase requisition form on a paper which after approval from several managers went to the purchase department where finally the goods were ordered. With the procedure of B2B procurement now, those who need goods log onto the Internet, select the required goods from an online catalogue and dispatch the purchase order via the Intranet; the workflow sends the request to the appropriate manager for approval after which the order goes to the supplies without bothering the purchasing department. This reduces the labor cost at the purchase department for handling such ad-hoc purchase orders.

In India, companies are linked to their suppliers and retailers through phones, faxes and recently electronic data interchange and very small aperture terminal (vsat). What is new now is that companies are using special software to do what used to be done manually earlier (Bhattacharjee, 1998). Supply chain systems deal with and analyse information from different points on the supply chain. If one supplier fails to deliver, the SCM software (SCMS) will help managers to locate another who can. SCMS also implements simultaneous processes and incorporates various constraints in operations. Enterprise Resource Planning (ERP) lacks the complex simulation and optimisation models to take care of needs like dynamic scheduling, backward scheduling and planning. SCMS can be implemented with an ERP package though world leaders in SCMS like Manugistics etc. sell it as a stand-alone product.

SCMS & ERP

There are major differences between SCM & ERP:

- ERP's primary function is to generate data, while SCMS can make sense out of the data for the purpose of decision-making.
- ERP systems are linear and interactive while SCMS is constrain-based and optimised. Thus data generated by ERP are used in the best possible manner by optimisation systems in an SCMS.
- ERP excels in transaction management. SCMS offers forecasting and decision support.
- ERP links processes only within the organisation while SC spans the entire supply chain, i.e. it goes beyond the organisation's boundaries.

SCM relies to a great extent on proper logistics support. Logistics is the process, of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements (Ernst & Whinney, 1987).

Role of Vendor Selection

Vendors are the best intangible assets of any organisation. Hence selecting the right vendor(s) is extremely important. The buyer must have a clear idea of rating vendors and improve relations with them. The ratings can also be used as a feedback to the vendors for improving their product. However, one has to follow a selective policy to pick and choose those that are suitable to his needs. Rating the suppliers helps to choose the best vendors and improve buyer-seller relations on an objective basis. Sometimes, suppliers also serve as public relations officers of the buying company.

A true measure of the effectiveness of the purchasing department is obtained by the quality of reliable vendors supplying goods and services. The absolute standard is difficult to define with any degree of exactness, but mathematical models are available to evaluate the performance of suppliers and grade them. However, many firms do not apply any formal technique; usually the buyer uses his own judgment in grading the supplier as good, satisfactory or unsatisfactory. The subjective judgment is not supported by any recorded evidence (Gopalkrishnan, 1990). Few companies also make use of a simple checklist. No rating is involved in these questions, but the information built over a period of time is helpful to the firm in the choice of supplier.

To protect production lines from shortage of raw materials, usually more than one supplier is found for each item. A supplier database is maintained for this purpose which is reviewed from time to time. Furthermore, to ensure that incoming materials meet relevant quality standards, a supplier rating must be carried out periodically. Since production begins with purchasing, and a purchasing program will not be successful unless cooperative buyer-seller relationships are established and maintained, supplier selection is one of the most important activities in purchasing. Effective supplier selection can also help companies achieve just-in-time (JIT) production (Li C.C. *et al,* 1997).

A supplier rating must be carried out periodically.

Outstanding supplier performance normally requires extensive communication and cooperation between purchasers and vendor over a period of time (Leenders *et al,* 1992). As quality improvement programs and just-in-time production efforts take hold, proximity of the vendor's premises to those of the purchaser becomes a significant consideration. In comparison to the hard-nosed way of procurement in earlier times, the ideas of sharing information and assisting vendors to improve quality, quantity, delivery, price and service performance are now prevalent.

The other end of SCM-Distribution

At the other end of SCM, companies are increasingly recognizing the fact that distribution channels represent an untapped opportunity for major cost savings and productivity improvements. The prevalence of strategic alliances and partnerships has made managers more willing to explore new ways of working together for mutual gain. Recent developments in shared information systems and integrated logistic systems make such cooperative efforts more feasible (Narus *et al,* 1996). Traditional firms try to meet challenges by forcing manufacturers and distributors to stock excess inventory or hire surplus personnel. Now, innovative managers are experimenting with various kinds of auxiliary support systems. Such systems allow a manufacturer and distributors to respond to extraordinary situations by sharing inventories and support services in return for a prespecified remuneration. What makes the system possible is Information Technology and integrated logistics systems that can monitor the availability of products and services, process orders and deliver products and services rapidly from distant locations to customer's site.

Ten years ago, most large companies worked with multiple suppliers; today, that is no longer the case. Prompted in part by the quality movement, more and more managers are shrinking the number of suppliers. The repercussions for distributors are becoming apparent. Sophisticated companies are increasingly choosing to rely on a small number of preferred distributors for maintenance, repair and operating supplies. In these relationships which are usually formalized through integrated supply-management contracts, the customer effectively outsources a portion of supply-management function to a distributor to reduce total transaction costs. Although such contracts typically require a broader market offering, integrated supply-management contracts provide tremendous opportunity for distributors to increase both sales and profits.

The Challenge

The supply chain has always been an important element of a company's business, but today more than ever, excellence in SCM differentiates the winners from the losers. Supply chain strategies traditionally focused on creating smooth links between departments and business units of a single company, such as between purchasing and manufacturing. Today however, research is focusing on how to optimise the supply chain strategies between firms and its suppliers and customers. Research on how to obtain greater efficiencies in product development, sourcing, production and distribution indicates that companies must interface more closely with suppliers and customers (Meredith & Roth, 1998). Another research area involves using electronic links to improve supply chain performance. Application of computer systems and software to logistics and SCM is now seen as crucial to success in marketplace. Technology platforms such as Enterprise Resource Planning (ERP) like SAP, Baan are being implemented in order to support orders and materials management and manufacturing and delivery information across the enterprise. ERP systems thus open up immense opportunities for supply chain research.

Application of computer systems and software to logistics and SCM is crucial to success in marketplace.

Managing the supply chain has become increasingly difficult with rapid adoption of lean manufacturing techniques like JIT and Flexible Manufacturing Systems (FMS) where timeliness of materials delivery is extremely critical. In traditional supply systems, suppliers and manufacturers operated in a rather autonomous manner. Suppliers had very little information on what manufacturers needed until they received orders from manufacturers. Similarly, manufacturers did not know what materials suppliers had until they placed an order and got a response. However, for organisations that implement computerized SCM systems, the links in the supply chain become truly intertwined. Further, with a well-implemented SCM system, manufacturers do not even have to place orders manually. The supplier's information system is aware' of the manufacturer's production information system. Consequently, the supplier knows exactly what materials the manufacturer needs and when.

ERP softwares like SAP, Baan and Oracle organize most day-to-day tasks, such as entering orders, tracking product shipments, scheduling production and updating sales forecasts and balance sheets. Using the Manugistics software, AP Lockheed, a division of Automotive Products Plc in UK has reengineered its supply chain to become one among the leading manufacturers and distributors of braking parts for cars and light commercial vehicles. SCM at the global level requires systems to analyze product flows, order patterns and inventories across the globe for which techniques such as data warehousing, data mining, decision support systems and an extensive communication infrastructure (e.g. Intranet, Extranet, Internet, EDI) are needed.

However, SCM might introduce new problems – both technical and non-technical. Technical problems include corruption of message contents and delay of messages due to computer system faults. As use of SCM and increased efficiency become more widespread, there may also be a negative impact on labour markets since current manual processes will be automated.

Conclusion

SCM shows a way to cost optimisation all along the chain, starting from customer order to the delivery of goods to him. It involves coordinated management of material, information and manpower in the entire process within an organisation and its objective is to optimise the total cost, improved total quality, maximise customer service and improve profit (Menon, 1999). According to a study by the University of Michigan's office on Automotive Transportation, the North American auto industry is in the midst of a major restructuring of its global supply chain (Holt, 1996). Under this restructuring, more decision-making and business processes are being shared between the auto makers and their leading suppliers. These changes are expected to result in improved productivity, product quality and profitability. The results of two surveys released by KPMG Consulting in USA show that companies lose millions of dollars every year because they fail to communicate efficiently with customers and suppliers (Savoic, 1998).

Decision-making and business processes are being shared between makers and suppliers.

The Institute of Industrial Engineers conducted a reader survey on SCM published in April, 98. When asked to rank the top three skills their companies need in order to achieve Supply Chain improvement goals, participants most often replied:

- Strategic Planning
- Supply Chain Planning
- Systems Integration

Other skills identified were Project Management, logistics modelling, outsourcing partnership negotiation etc. When asked to rank the 3 most important benefits a company hoped to gain from Supply Chain improvement, participants most often answered:

- Reduce Operating Costs
- Improve Responsiveness/Reduce cycle-time
- Improve Customer Service

The purpose of supply chain improvement is to provide significant competitive advantage to the companies comprising a supply chain. Industrial engineers have a lot to offer in support of supply chain improvement efforts and should be able to provide tools, techniques and personnel to support SCI efforts. To make a greater contribution, they should develop skills in the areas of strategic planning, supply chain planning and systems integration.

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SCM, ERP & the Internet

Nesa L'abbe Wu

Business to Business (B2B) interactions via the Internet can well serve supply chain management (SCM) and enterprise resource planning (ERP). This paper defines these two business concepts and looks at what has been and is being developed in terms of Internet, Extranet and e-commerce. The paper also addresses the future development challenges for any industry that wishes to integrate SCM and ERP with the internet/ extranets.

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Though supply chain management (SCM) is not a new topic in operations management, it is the least perfect concept in business today. Supply chain management, according to Dr. Michael Hammer, means everything that happens to fill the demands of the ultimate customer. Thus, supply chain management looks at the enterprise as a whole. It includes not only the relationship amongst all functions within the firm, but also with all trading partners outside the firm.

The objective of a competitive supply chain is to weave each of the trading partners into a seamless fabric of information flow, physical distribution flow, and cash flow for the benefit of the end customer. The trading partners achieve their profit, or loss, through their ability to work together while recognizing that each organisation is largely dependent on the other. By leveraging the resources of its trading partners, a company within the supply chain can gain access to a larger market, and win a larger market share. It can do this with smaller investments of its own. Supply chain management aims at increasing customer service, while increasing return on investment. To realize these benefits, however, there needs to be an effective control of the supply chain. Supply chain optimization involves supply chain planning, production synchronization, and execution control across the entire chain.

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While there are many production and distribution paths that products can take en route to the customers, the key underlying activities are essentially the same. Raw materials are brought into the manufacturing plant, and after being subjected to a series of processing, handling, storing and shipping steps, are ultimately delivered to the customers' sites as finished goods.

These standard steps yield systems through which both materials and information flow. The more integrated the company's manufacturing system is and the more effectively and efficiently its employees manage and process information and materials flow; the more the company will successfully overcome challenges of shortened product cycles, increased product customization while reducing scrap, cutting costs and boosting productivity.

Enterprise Resource Planning (ERP)

At their outset, enterprise resource planning (ERP) systems were large-scale projects that provided companies with a unified view of their business, but were often expensive and hard to use. Now, ERP is becoming a more legitimate choice for small and medium- size businesses as it has evolved into more modular, easier-to- use software. Enterprise resource planning systems have become increasingly important in most business environments due to their ability to provide flexibility and visibility to key functions in the organisation. These systems integrate disparate sub-systems within an organisation and give companies a unified enterprise view of the business common to all functions and departments. They utilize a common enterprise database, where all significant business transactions are entered, recorded, processed, monitored, and reported.

However, harnessing inside information alone is not enough to continue being competitive. Enterprise resource planning systems must leverage their systems to a collaborative effort between trading partners and divisions to harness the power of "outside" information. With the explosion of the Internet and the new paradigm of e-commerce, ERP systems are being opened to all trading partners.

The advent of the World Wide Web as a viable platform for commerce has allowed companies to go beyond the constraints of physical facilities to improve customer service, to tighten supply chain relationships, and to better translate raw data into meaningful business strategies. The Internet allows companies facilitating ERP packages to carry out things such as order-entry support and verification of shipping information.

Some companies (Dell Computer Systems for example) use the power of the Internet to link up to ERP systems of trading partners to optimize the supply chain. This allows these companies to better align supply and demand to create value for the enterprise by improving visibility into the supply chain bottlenecks and constraints. This interoperability and visibility also allows for real-time-based synchronization and resource optimization, a considerable reduction in inventory and better delivery performance. Few companies, however, have fully realized these benefits because of the difficulty of interfacing different enterprise resource planning and supply chain management packages. Thus, the challenge that lies ahead for ERP software vendors is to find a common platform that could be used by all trading partners regardless of the ERP package being used.

The challenge is to find a common platform that could be used by all trading partners.

The Internet, Extranets & E-commerce

Supply chain partners have not shield away from trying to manage exchanging data amongst themselves and leveraging their investment in technology towards efficiency and increasing competitiveness through the Internet and Extranets. For example, the Big Three automotive manufacturers and their tier one suppliers (largest suppliers) have been using the automotive network exchange (ANX). The ANX is a private, secure, high performance Extranet that joins suppliers and buyers up and down the supply chain for CAD/CAM file transfers and electronic data interchanges. Future plans for ANX include developing applications to support CAD/CAM collaboration, video conferencing, e-mail trading, and posting advanced shipping schedules to run on the backbone of the network. The industry speculates that ironing out current inefficiencies of the ANX up and down the supply chain will decrease the cost of producing a car by as much as $1,200.

Aiag's manufacturing assembly pilot (MAP) project is an example of a success story of the automotive network exchange (ANX). The project involved two-year co-operative effort of three automakers and thirteen suppliers in multiple tiers. MAP showed that the transmission time of information down the supply chain could be cut from one week to about one day per tier. The MAP report indicated a potential saving for the American auto industry of $1 billion a year or about $71 per car in a typical 15-million-production year (as reported by Karl Schohl, ANX business manager for Detroit based Aiag).

Cost savings in the auto industry and other industries have been primarily achieved through a simplified order conveyance process such as electronic data interchanges (EDI). These interchanges are point-to-point exchanges where a single trading partner is identified and a protocol developed to transmit data. The advantage of EDI is that it provides a complete, secure and integrated package to support the transac-

tions. However, EDI is extremely expensive to maintain and, consequently, very difficult to adopt by intermediate, third and fourth tier suppliers. e- commerce allows trading partners (including those in the third and fourth tier) to build a transactional network using the Internet at a fraction of the cost of EDI and with relatively more ease. Its ability to submit close to real-time data and to reach anyone is yet two more benefits. These advantages, however, could quickly diminish, as more trading partners become involved in the process. The Internet, unlike EDI and its value-added networks (VAN) that allow transactions to be completed, only transmits data. It does not yet have the capability to manage the process of data transmittal. What the market wants is the implementation of the original vision of electronic data interchange: to create universally scalable system-to-system connections that require only a one time investment and that allow everyone to continue to use own applications and computer systems. Due to the lack of technological capability, only a fraction of this vision has been delivered.

EDI provides a complete, secure and integrated package to support transactions. e-commerce allows trading partners to build a transactional network using the Internet at a fraction of the cost of EDI.

Others, like Compaq Computer Corporation, have opened electronic access to large customers to review product information, enter orders, review contracts, and handle payment issues over the Internet. These steps have reduced costs for both Compaq and its customers, and have enabled the company to maintain competitive edge by offering personalized products. Additionally, Compaq uses a new simulation tool called supply net workbench to manage much of the supply chain flow process. This software allows planners (those who manage the suppliers' materials into Compaq plants) to simulate what is going on and to send that information out to the supply net web site. The supply net workbench is linked to Compaq's advanced planning and scheduling system. The company's order scheduling software looks at the order book's actual sales and compares it to the forecast and then performs finite factory scheduling and materials requirements simulation. The material requirements planning system, which is directly linked and interfaced with Supply Net, sends planners (who are also the buyers in this case) an electronic mail message to inform them that there is a new materials request to be processed. As soon as this is done, the system sends a page or e-mail to the suppliers telling them to check the new (updated) materials level to act accordingly. This supply chain management system is used throughout Compaq's business unit (Harrington, 1999).

The Internet offers many opportunities for companies to cut costs and improve responsiveness to customer needs. Procurement, simplified VAN and EDI networks, as pipelines for e-commerce, and web cataloging are only a few examples of these opportunities. To realize the full benefit of these, however, trading partners must be willing to collaborate to the fullest. Information needs to be viewed by supply chain partners as a critical cornerstone to achieve competitive advantage in the market place. Trading partners need to realize that to be able to compete in the future they need to be part of a powerful, seamless, and well-integrated supply chain. Competing on an individual basis will no longer be the norm. Supply chains will be competing against each other for market share and leading positions. Willingness to collaborate and dedication to achieve it are at the core of supply chain success.

The latest announcement of such a collaborative system is COVISINT. Covisint stands for: CO (connectivity, collaboration and communication), VIS (visibility that the Internet provides and the vision of the future of supply chain management) and INT (integrated solutions the venture will provide and its international scope of exchange). Its players are Commerce One and Oracle (the technology providers), the automotive industry partners, such as GM, Ford, Daimler Chrysler and Renault/Nissan and their tier one suppliers such as Lear, Dana, Johnson Control and others. This system is still in its formative state. The tools of solution in this system include product development, procurement, supply chain, portal services and others. Covisint will help its customers move product development activity to a model that provides real time collaboration and greatly enhances integration among numerous, and often global, partners, via Internet. It will become the virtual project workspace with the establishment of a true collaborative product design environment between a company and its supply chain. Covisint will offer collaborative product design solutions that can benefit the entire product development community by integrating and synchronizing teams, processes and plans across a company's geographies and across its supply chain. It is alleged that Covisint will support each company's unique procurement process needs for both production and non-production material, while integrating multiple systems where many sellers can communicate with many buyers. This will transform the role of procurement from an administrative role to a strategic role. The paper-intensive purchasing process can now be automated and procurement professionals now will be

able to focus on value-added tasks, such as improving supplier performance and developing procurement strategies. Covisint will enable the procurement function through on-line catalogs, auctions, quote management, asset management, financial services and procurement links. Covisint will also allow individual organisations to see the current and future status of their supply chain: material flows, inventory levels, and capacity constraints. Trading partners in the supply chain will collaboratively communicate and develop production and shipping schedules using standardized information and common systems. This will result in a reduction of inventory, improve manufacturing efficiencies, reduce cost of transportation and reduce non-value-added costs of travel and paperwork. Companies can manage their supply chain via Covisint's forecasting, supply network and logistics capabilities. It is the goal of Covisint to achieve the following objectives: 12-18 months vehicle development cycle; compressed order-to-delivery cycles; increased shareholder valuations within the automotive industry; greater asset efficiency and utilization; higher profitability with direct impact to the bottom line; more integrated supply chain planning; and reduced business process variability. Covisint, a single global portal providing an integrated business-to-business supplier exchange, that started in February 2000, has a long way to go and represents a great promise.

The Future Challenge for SCM & ERP

Supply chain management (SCM) has moved into the spotlight as companies turn from streamlining internal operations to improving the exchanges that occur between trading partners, either inside or outside the organisation. Companies across the world are implementing enterprise resource planning (ERP) and are aiming to make all operations—from production to delivery to the customer—smoother, more efficient and linked by one system. However, ERP systems alone do not deliver what companies need to survive and thrive in today's marketplace. Leveraging ERP systems to the Internet, forging good supply chain relationship and customization of products and services are essential to future success in business. Online business will not be successfully carried out without a solid ERP foundation. This foundation is essential when bringing suppliers together to work from a common platform and to plan their operations according to real-time, comprehensive databases. ERP does just that.

ERP in today's marketplace needs to be complemented by web presence and the ability to carry out business functions over the Net. This functionally allows companies to be more responsive to customer needs by reducing setup times, cutting inventories, and significantly reducing lead times. The flow of information through integration programs, whether through interfacing ERP or SCM applications, has been cited by many professionals to increase visibility and allow companies to generate more accurate forecasts. Nevertheless, doing business on the Internet involves more than launching a jazzy web site. The Internet is more than a web communication channel. Using the Internet to conduct or facilitate daily operations requires a comprehensive strategy that connects customers with employees and with suppliers (the front office and the back office) by using the Internet as the strategic foundation. This foundation allows individual businesses and supply chains to grow, retain customers and improve efficiencies.

ERP needs to be complemented by the ability to carry out business functions over the Net.

While supply chain management systems are a critical component to drive growth and retain customers, enterprise resource planning systems help improve efficiencies by cutting down waste. Separate and independent point solutions for sales, marketing, call centers, procurement, etc. alone are not enough. Companies need to take a holistic view of supply chain experiences and build a comprehensive infrastructure to support it to be able to cut costs and truly benefit the end customer. To do so, however, companies within a supply chain must be able to follow the same notes and be on the same page. Nevertheless, interfacing applications have been the most arduous task for many software vendors and manufacturing companies. Although EDI has been working well for many companies, it is quite expensive and not feasible for third and fourth tier partners to adopt.

Thus the challenge that lies ahead is finding a cheap way to interface disparate systems to realize the benefits of supply chain management and enterprise resource planning systems promise without a huge capital investment. In the future, without such an interface many companies will be left out. Companies cannot afford the time or cost to link together dozens of disparate systems and point solutions. Only a fully integrated application can deliver on the benefits of integration and accessibility to information. Finding this integrated application may be the challenge of today, but in five years it will no longer be discussed. It will just be here.

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Competing on e-enabled Supply Chains

M.L. Singla

To reach the customers in a speedy, cost effective, and zero-error manner, companies need to manage their entire supply chain both on the supply, (upstream) as well as distribution, (downstream) side of the supply chain. SCM decisions include location decisions, production decisions, inventory decisions, and transportation decisions. For these decisions to be optimal, companies need support of data pertaining to organisational operations as well as the entire supply chain on a real time basis. Electronic Data Interchange, the invention of 1970s, did offer a significant potential to companies for automating the supply chain, but the real boost has been given by the Internet and Enterprise System technologies. Systems like ERP and extended web-enabled ERP systems, have literally revolutionized the Supply Chain Management. To be in a position to implement Web-enabled SCM, a company has to reach the fifth stage of IT implementation on the Nolan's Stage Growth Model states the author.

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"There is only one boss—the Customer. And he can fire everybody in the company, from the chairman on down, simply by spending his money somewhere else", said Sam Walton, founder of the Wal-Mart Chain of Super Stores. And this boss is not bothered as long as some other business organisation is able to deliver better, cheaper, and faster products or services. Sahay *et al,* (2001) while analyzing the objectives of supply chain management (SCM), have reinforced this view. According to them, increase in customer satisfaction and lowering costs are the two most important objectives of a SCM project. Inefficiency, regardless of whether it is because of the organisation or its supplier or its supplier's supplier, will add to the delay, cost, or poor quality of the products/services. It is this context that this paper makes an attempt to explore how the business organisations need to exploit Information Technology(IT) in managing their supply chains so as to compete in their respective industry segments.

Supply Chain Management

There are no competing organisations or businesses or chief executive officers and their teams any more, there are just competing supply chains. The statement needs no substantiation in the present context of cross-organisational integration; seamless flow of goods and information; and evolving virtual corporations. The Supply Chain has been defined as a global or local network of organisational entities that encompasses all those activities with delivery of products and or services to the end customers—from the procurement of raw materials through an engineered flow of information, and physical distribution, thereby connecting the suppliers' supplier to the customers' customer. In other words, a supply chain would necessarily include understanding the stream of material flow from suppliers' supplier, through the manufacturer, through our customer (internal and external), and upto the customers' customers. Supply chain functions generally include production scheduling, advanced planning, sourcing and procurement, order processing, inventory management, forecasting, warehousing, transportation and

logistics, sales force automation and customer service. The organisation of all there internal and external processes required for smooth operation of a supply chain is called Supply Chain Management.

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The supply chain decisions include location, production, inventory, and transportation decisions both at the strategic and operational level. The new generation supply chain strategy focuses on Synchronized Supply Chains encompassing three major structural changes, viz. collaboration with supply chain partners to synchronize operations, enabling technologies and internet as key enablers to supply chain management, and restructuring of supply chain organisations. A good supply chain focuses on involvement and empowerment of business partners; excellent business-to-business communications; early training to all stakeholders; and collaboration with upstream and downstream operations using information technology.

The House of Supply Chain Management as suggested by Stadtler (2000) views the ultimate goal of a SCM to be attaining organisational competitiveness and the means of reaching this goal to be customer service. According to Stadtler, these two form the roof of SCM, resting on two main pillars of integration of a network of organisations and coordination of information, materials, and financial flows. The foundations consist of logistics, marketing, operations research, organisational theory, purchasing, and supply, etc. The role of Information Technology has been outlined as a great facilitator of integration and co-ordination. The organisations, which compete on supply chains, are expected to exhibit a great leadership in their top brass and process orientation in their operations. Though different people include different elements in a supply chain decision matrix, the competing objectives for a supply chain include:

- Purchasing of stable volume and large quantities of requirements; flexible delivery timings; and little variations in mix.
- Warehousing of low inventory levels; reduced transportation costs; and quick replenishment capabilities.
- Manufacturing of high quality products ensuring a long run production schedules achieving a high productivity at low costs.
- Assurance customers of high stock availability; shorter order lead times; and a wide range of products.

The Process Orientation

Michael Hammer (2001), the celebrated father of the concept of Business Process Reengineering (BPR), has very aptly remarked that "You've cut the waste out of your own operations. Now, you face an even tougher challenge: streamlining the processes you share with other companies". Companies will have to start managing business processes not only of their own organisations but also of business partners in the entire supply chain. This shall not only remove delays in the processes being executed, it will also help cut down the duplication and redundancies in the processes. Streamlining cross-organisational processes also leads to simplifying the supply chains. The focus of a group of organisations shifts from just co-ordination to effective collaboration in the delivery of products and services to the end customer. Sharing of information across organisations sharing these business processes renders the entire supply chain more customer oriented.

Focus of organisations shifts from co-ordination to collaboration.

Hammer (2001) has listed four different steps to redesign business processes for achieving super-efficiency in supply chains:

Scoping	• Identifying the appropriate business process which offers substantial improvement scope and selecting an interested business partner
Organising	• Setting up an executive steering committee and convening a design team
Redesigning	• Designing the new, integrated process for gaining customer satisfaction and competitive advantage
Implementing	• Rolling out the new processes and communicating effectively with all stake holders in the partnering companies

Streamlining inter-organisational processes is a very hard, but the most desirable business imperative in the contemporary context.

Supply Chain Assistance Organisations

Industry is witnessing an emergence of a newer form of supply chain business associates. There could be partners, which do not contribute to the primary activities of the value chain of an organisation, but facilitate value creation in the support activities. Following the Core Competency Theory suggested by Hamel and Prahalad (1994), an organisation may benefit by involving business associates from the secondary activities spectrum on the value chain to strengthen their supply chain network. For example, an organisation may benefit by involving a banking organisation to assist in:

- Cash Management
- Credit Management
- Collection and payment services, and
- On-line Debit and Credit facilitation through Internet

These partners assist the companies by crediting and debiting the supply chain partners on the due date without any administrative hassles. This may also lead to simplifications of reconciliation and integration of these transactions with the company management information system. The information becomes globally available leading to effective monitoring, control, and auditing. These partners may also assist in handling the suppliers' control, and auditing. These partners may also assist in handling the suppliers' payments on behalf of the company ensuring vendor discounting and cost savings for the company. These partners provide requisite financing and deal with larger number of suppliers and dealers on either side of the supply chain. Apart from the company, these partners also assist the suppliers as well as dealers and distributors of the company in their funds management thereby making the entire supply chain more responsive and effective for the end consumer.

Enterprise Systems & SCM

Enterprise systems facilitate seamless flow of information across diverse functional business units, departments, and geographic locations. Mostly internal to organisational functioning, these systems are popularly called Enterprise Resource Planning (ERP) systems or Enterprise Systems (ES). Different modules of such systems support a range of business activities such as accounting, manufacturing, sales and service. These systems which started as simply back-office processing systems, now have started having significant competitive impact on the front-office too. Use of Internet technology based internal information networks called Intranets have facilitated extension of these enterprise systems so as to support supply chain operations all through the organisation. Though these systems are known to be inflexible and slow in implementation, they have led to creation of business value by (Davenport, 2000):

- Reducing cycle time
- Faster information processing
- Improving financial management
- Laying the foundation for e-commerce
- Making the process knowledge explicit

SCM happens to be the hottest area of concentration for ES these days. Firms find sufficient business reasons to leverage ES for optimizing their supply chains. One of the most significant reasons is cost-effectiveness and competitive edge. Also the availability of tools to implement the SCM solutions motivates managers to view these systems favourably. The organisations have found these to be effective both for internal as well as external management. Implementation of enterprise systems such as ERP helps an organisation to achieve:

SCM happens to be the hottest area of concentration for ES.

- Cost cutting in internal supply chain operations by destroying the traditionally existent inter-departmental walls. This itself can lead to a phenomenal cost cutting thereby rendering an organisation to be competitive.
- Improving efficiency across the extended supply chain by leveraging the implementation of such solutions across the enterprise walls in collaboration with the vendor and distributor sides.

Though by managing the internal supply chain, we can improve business value and cut down the costs of internal operations, it is now being realized that by improving efficiency across the organisational boundary, the benefits can be multi-fold. Apart from the above two benefits that an organisation is bound to reap, the biggest advantage is that of rendering bigger transaction is

bound to reap, the biggest advantage is that of rendering bigger transaction value to customers. Excellence in SCM can deliver very high quality service to the enterprise customers.

By managing the internal supply chain, we can improve business value and cut down the costs of internal operations.

E-Business & SCM

The Internet has just started changing the landscape of the businesses and societies. Its global reach is making it the ideal medium for networking with either end of the supply chain. It even scores over the traditional Electronic Data Interchange (EDI) systems. The traditional EDI systems needed maintenance of a very complex privately owned communication system for successful implementation of an IT solution, which has been effectively handled by the existence of Internet. A disruptive technology like Internet has just taken 4 years to reach a milestone of 50 million users as against 16 years for Personal Computers and 38 years for Radio Technology (Norris *et al,* 2000). Every organisation which dreams of using Internet technologies for creating business value will be expected to pass through three distinctive stages : e-commerce (business transactions taking place on the internet); e-business (primarily based on internet technologies aimed at improving the business performance by connecting all value chain partners); and e-partnering (customer focused relationship based on trust for optimizing the entire value chain). Whereas ERP is more inward looking (focuses on internal enterprise operations such as functioning of different departments), e-business focuses on communication with external stakeholders too. A supply chain management solution will look for ERP to ERP connectivity across organisations and value chain integration for business partners.

Organisation which dreams of using Internet technologies for creating business value will pass through e-commerce, e-business and e-partnering.

According to Patel and McCarthy (2000), companies like FedEx and Ingram Micro have leveraged e-business for differentiating their services from competitors, and increasing their competitive advantages. Though developing an e-business will need a clear cut vision of what you wish to implement, proper implementation of e-business can deliver the yield of greater efficiencies; higher profits; improved customer relationships; and increased business value. In nutshell, e-business implementation does offer a great potential of enhanced supply chain efficiencies.

A marriage between SCM and e-business can be termed as e-SCM. e-SCM can be characterized by cultural changes as well as changes in management policies, organisational structures, business processes, and performance measures. An effective e-SCM would be expected to have the following components (Norris *et al,* 2000):

Supply-chain replenishment: Web enabled customer ordering across the extended enterprise.

e-Procurement: Web enabled requisitioning, sourcing, contracting, ordering, and payment.

Collaborative Planning: Facilitating buyers and sellers to come together to forecast demand and plan supply of goods and services.

Collaborative Product Development: e-Business facilitating development to a product idea through shared information and knowledge across organisational teams.

e-Logistics: Leveraging web-enabled processes to manage the warehousing and transportation activities.

Some of the prevailing examples of SCM based on internet, intranets, and extranets include (Christopher, 1998):

- Customer Service such as Electronic Help Desk
- Marketing such as electronic malls and market research
- Information retrieval such as electronic catalogues
- Supplier relationship management such as payments
- Financial transaction processing such as managing accounts
- Internal communications such as e-mail
- Sales force automation such as order processing

SCM initiatives

India has started realizing the potentials that SCM

promises. There have been various functional areas under focus for implementation of SC solutions. Management of Inbound Logistics has been a very potent domain which offered large pay-offs, particularly wherever there are huge inventories being bought from outside vendors. For example, Maruti Udyog Limited; Tata Engineering; and Hyundai have been focusing on various components of their value chain. For example, Maruti exploits both the Milk Run System(MRS) as well as the Hub and Spoke Model for their inbound logistics management.

Another category of initiatives includes McDonalds – creating distribution centers near the markets for storing ingredients and creating refrigerated vehicles for supplies; Modi Xerox where entire logistics movement has been moved to on-line; Hindustan Lever Limited(HLL) which has already reduced its suppliers' inventory level from 7 days to 3 days and plans to initiate a net based supply chain management system, etc. HLL's new implementation Stocky promises to manage stockists' inventory, logistics, and financial data. Stocky is a window based SCM solution which is likely to assist HLL in getting dealers and stockists on-line. Samsung Electronics India extended its supply chain to incorporate customers and after sales service for the dealers and brought down the distribution cycle to 20 days from 40 days. Blue Star Limited has exploited an e-business enabled supply chain initiative to bring down its order-to-delivery cycle time from 103 days to 34 days. Shoppers' Stop is eyeing its future initiatives such as Automatic Data Capture at the distribution centres and business-to-business connectivity with its 300 suppliers in order to achieve a seamless effectiveness of the whole chain.

IT Learning & SCM

Though IT thinking has undergone a fundamental change, the basic IT management paradigms still follow a learning curve in business organisations. Emerging technologies such as Swipe Cards, Smart Cards, Global Positioning Systems, or e-Commerce based systems assume existence of an integrated information processing system in place. Dvorak *et al,* (1997) have identified six different principles which guide the implementation of a high performance IT initiative. These six principles include:

- Making IT a business-driven line activity
- Making IT funding decisions value based decisions
- Driving simplicity and flexibility throughout the initiative
- Demanding near-term business results from developments
- Driving constant operational improvements
- Building up an IT smart company

Case *et al,* (1992) view IT 'as an organisationally neutral phenomenon capable of reducing managerial span of control'. According to them, the organisations could get more responsive by using IT, and IT can assist organisations in overcoming geographical restrictions. Geographical Information Systems(GIS) is a technology, which offers unmatched potential in this context. IT can help a company (Porter & Millar, 1985) in achieving cost leadership; creating product differentiation; targeting a focus niche market.

IT can help a company in achieving cost leadership; creating product differentiation; targeting a focus niche market.

Table 1: Nature of Scott Morton's IT-Induced Reconfiguration

Level	Theme	Potential impacts	Major objectives	Management implications
One	Localized exploitation	Potentially high savings in narrow areas of business	Reduced costs and/or improved service	Identifying firm-specific areas for exploitation
Two	Internal integration	Integration offers both efficiency and effectiveness	Elevating IT as a strategic resource	Articulating the logic for integration
Three	Business process redesign	Powerful in creating differential capabilities in the marketplace	Re-engineering the business with IT lever	Strategy – IT alignment
Four	Business network redesign	Opportunities for creatively exploiting capabilities	Creating a virtual organisation and occupy a central position in the network	Articulating the logic of network redesign for the firm
Five	Business scope redefinition	Altering the business scope both proactively and reactively	Identifying new business as well as potential threats	Identification of new scope of business

Source: Scott Morton, 1991.

Scott Morton (1991) has provided a five level framework for understanding the IT induced reconfigura-

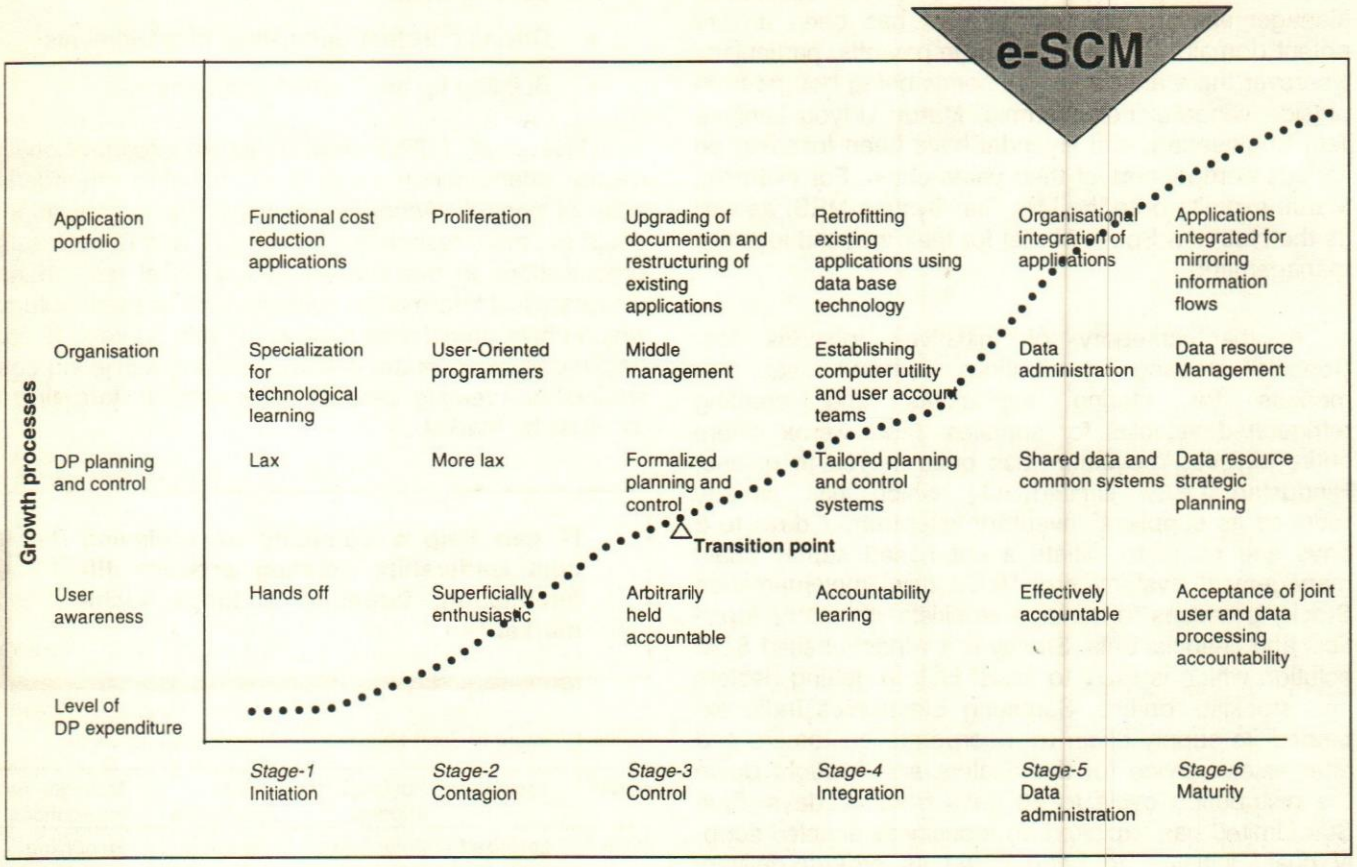

Fig. 1. e-SCM in a Stage Growth Perspective

tion of business strategy as shown in Table 1. As per this model, there are two phases of IT introduction in any organisation: the first being evolutionary and the other being revolutionary. At the first level, i.e. localized exploitation, IT is implemented within a functional area with the prime objective being local efficiency and effectiveness. The second level is the internal integration between such (previously localized) systems and applications. The this stage, not only are the other areas automated but systems are holistically rationalized by adoption of common IT platforms, coordination and cooperation. At the third level, i.e. business process redesign, there is thorough revaluation of the entire enterprise value chain and envisaging far reaching change programmes. At the fourth level, namely the business network redesign, there is reconfiguration of the scope and tasks of the business networks involved in the creation and delivery of products and services. The last level, the business scope redefinition, involves migration of functions across the enterprise boundaries, to the extent of changing the organisation's conception of its business.

Growth of Information Technology function in an organisation has been of interest to researchers. Nolan (1979) suggested that the IT function in an organisation grows through six distinctive stages of growth. He suggested a Six-Stage Growth framework, an improvement over the earlier model (Gibson & Nolan, 1974), for understanding growth of IT IN business organisations. Some researchers have found the framework to be wanting in terms of lack of real life data support for the purpose of validity of mapping of organisations on this model, but researchers have considered this as a consequence of inadequacy of proper research design, and non-availability or insufficiency of relevant data. This model can help organisations understand the logic, direction, and destination of change.

The original model as proposed by Nolan is shown in Fig. 1. As could be seen, there are numerous growth processes, which assist in establishing the mapping of an organisation on this model. The organisations arrive at a state, termed as Transition Point towards the end of third stage, beyond which the entire emphasis of the computerization activity changes from technology management to data resource management. Top Management Interest and User Involvement also undergoes a radical change as an organisation progresses

from initial stages to the later stages on this model. Some of the observations on this framework could be summarized as follows:

- IT Budgets keep rising from first stage onwards with a marginal smoothening during the third and fourth stages of growth. The budget growth becomes steeper towards the fifth stage of growth.
- Organisations become more focused as we cross the third stage of growth.
- Applications travel from simple cost reduction to those which mirror information flows.
- The IT Organisation shifts its focus from programming specialization to data resource management over the stages. An important portfolio like Data Administration has to evolve during the fifth stage of growth.
- IT Planning and Control comes under close scrutiny beyond Stage 2. Organisations which are not able to take the same, stay there.
- Users can not afford to be critical outsiders beyond Stage 2 and have to start playing a participative role in the IT activity.

While organisations have to travel through the Stage Growth Model for implementation of IT based solutions, each organisation has to go through initial stages until these start harvesting the benefits of using IT. For implementation of an SCM solution, particularly an e-SCM solution, an organisation has to be on the fifth stage of growth, as shown in Fig. 1. Stage 5, i.e. Data Administration, is characterized by:

- Organisational integration of applications – within the organisation as well as with external systems by developing inter-organisational systems
- Shared data and common systems
- Users being effectively accountable
- EDI systems already in place
- ERP based Enterprise Systems being implemented
- Intranet, Extranet, and Internet based solutions being developed
- All partners of the SC ready to take on the Web-enabled solutions

Only by he fifth stage can web supported inter organisational systems become a reality.

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Managing Supply Chain Through BPO & HRO

Dipak Kumar Bhattacharyya

This paper focusses on BPO (Business Process Outsourcing) and HRO (Human Resource Outsourcing) concepts, which are emerging areas of SCM and shows how SCM reinforces these two new areas.

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Supply Chain Management (SCM) is an integrated approach to outsource by cost optimisation. It cuts costs, reduces inventory, shares basic demand forecast with trading partners for mutual advantage, etc. Even though the initial thrust of SCM was to integrate warehousing and transportation for efficient distribution at reduced costs, over the years SCM has become a strategic tool to increase market share and multiply customer satisfaction. The basic hypothesis on which SCM sustains is efficient interaction and inter-dependence of planning, people and processes i.e., three Ps which together reinforce output that satisfies customers, irrespective of their geographical dispersion. Dial a toll free number (at local rate) that may be located at Bangalore and get the services sitting at Delhi within an hour. This is what is happening now in cases of computer hardware and will happen tomorrow for everything that encompasses your organisational requirements or even requirements of your house. Today you get a *pizza* just a phone call away, tomorrow you will get everything at no extra cost sitting at your home, even faster than what could have been your time for personal shopping. In fact you would save more both in terms of your valued time and travel expenses. "Out-source everything that's non-core"—this is what Peter Drucker says for today's organisation. With IT interface, SCM has changed from its traditional Logistics management approach to many new areas of corporate outsourcing, even encompassing HR functions. Business Process outsourcing (BPO), to be more specific, is relatively a new concept and an extension of SCM Philosophy, which is revolutionising the management practices of today's organisations. Take for example, British Telcom. In 18 months, they have re-defined their strategies 8 times. Or for that matter a desi organisation—Reliance, who had surpassed Du Pont and Dow in terms of per employee profitability, yet with a HR strategy, which is more oriental and orthodox than trendy. All get highly paid, all are with a high designation profile, yet all are enslaved—it is a management

by direction, not management by participation. You cannot afford to leave Reliance, because you have no alternative! These are the two extreme cases, where BPO and Human Resource Outsourcing (HRO) have different connotations.

Business Process outsourcing is an extension of SCM Philosophy.

Competency Models

Everytime an organisation changes its strategy, it needs to relook into the competency profile of the people. Competencies are sets of behaviours, which encompass skills, knowledge, abilities and attributes. Competencies need to be assessed at organisational level and at individual level. Individual competencies together reinforce organisational competencies. Workforce planning exercise helps us analyse the gap individual and organisational competencies and develop a competency model that addresses the strategic requirements of the organisation. Every organisation tries to fill this gap by training, retraining and redeployment. When they fail, they go for rightsizing of manpower. Without going into the debate of sanctity of redundancy decisions, which has by now become rampant, this questions our practices of institutional employment! What we find as HRO or BPO, today, started longtime back with the institutionalisation of Employee Leasing in developed countries. With its birth in the USA in 1982, by 1985, it had an annual revenue of $1 billion. Looking back to history we find that such firms started flourishing in the USA, especially after the enactment of the Tax Equity and Fiscal Responsibility Act (TEFRA), 1982. The 'top-heavy' Pension Plan in the USA disproportionately favoured company owners and senior executives (Key employees) over lower level employees.

Till 1982, such practice was continuing and companies were also enjoying tax benefit for such a partisan policy. TEFRA instituted the requirements that such top heavy Pension Plan (the plan which provides more than 60 per cent of the accumulated benefits to key employees) will cease to enjoy tax benefits unless shared with all employees. But the exception clause allowed companies to exclude leased employees from their pension programmes if the leasing companies were having their own pension plan and contributed atleast 7.5 per cent of the salary in that scheme. This exception clause helped the employers set up their exclusive Pension Plan and transfer their employees to leasing companies, and take them back under leasing agreement. To such exclusive pension plans, companies can contribute as much as 200 per cent of the salary and thus can shelter profit from taxes. Today leasing companies provide various services, absolutely relieving the client companies from personnel problems for a percentage of the pay roll, which generally varies from 5 per cent to 10 per cent. Such services include; recruiting, training, supervision, wage setting, handling of labour disputes, periodic performance appraisal, preparation of pay roll, maintenance of pay-records, administration of vacation and sick time, Government paper work, preparation of employee-related reports and audits, etc.

Initially, leasing companies' main target as prospective clients was small business corporations, employing less than 50 persons. Such small companies' own benefits scheme being less attractive, they usually experience high rates of labour turnover. Moreover, as such companies are mostly owner-managed, their pension schemes disproportionately favour a handful of key employees, causing much discontent amongst the rest. Because of their relatively poor benefit schemes, skilled manpower feels less attraction, which deprives them from quality labour services and workmanship. Again high cost of labour inputs fails to give them a competitive edge over big business corporations. All these factors, together with the TEFRA, made small companies target clients to leasing companies in the USA. From the USA, employee leasing concept, in more institutionalised forms spread across the globe, including India. In India, high technology is gradually finding a place in organisations for increased productivity, decreased labour cost and for enhanced safety. Under utilisation of capacity, rising industrial disputes (more lockout prone now than strikes) and consequent loss of mandays, surplus manpower, low labour productivity are some crippling characteristics of Indian industries. In distribution of total earnings, as percentage of value-added, Indian workers are sharing more than their counterparts in the developed countries like; UK, Japan and the USA. This justifies the perception that Indian industries are burdened with high labour costs, even though in absolute terms, such costs may be quite low. These apart, Non-Wage-Labour Cost (NWLC) burden is globally rising. NWLC is a load on paid wage costs, in terms of deferred benefits to the employees and the personnel overhead cost. NWLC in U.K. is 40 per cent of the paid wage costs, in the USA it is 38 per cent, in Germany 82 per cent, while in France it is as high as 93

Retaining employees from leasing companies, leads to labour cost savings.

per cent. In India NWLC varies between 20 to 25 per cent of the paid wage costs. Retaining employees from leasing companies, therefore, leads to labour cost savings and thus can enhance the profitability of the organisations.

C.K. Prahalad's core competency theory in 1990s, which suggests to identify core competencies and focus only on them and get out of everything that is non-core, was initially product/service- centric approach. Over the years, this theory proved to have its renewed thrust in intra-organisational functions and operations, which calls for outsourcing all non-core or non-value adding activities and confining attention on core matters which are crucial to business.

In 1989, came another mind-boggling idea from Charles Handy wherein he predicted three different organisational models, which are distinctly different from what we are used to. His 'Shamrock' organisational model is based around a core of essential executives and workers supported by outside contractors and part-time help. This model explains the move to out-source non-core functions. The second emergent organisational structure identified by Handy was the "Federal organisation" – more improvised decentralisation where organisational centre co-ordinates influence, advises and suggests and does not dictate terms or make short-term decisions. The third type of organisation of Handy is known as 'Tripple-I', i.e. information, intelligence and ideas. These apart, need for building organisations in line with the capability profile (David Cohen), shortage of critical skills, changing process, systems, culture and management practices, global competitiveness, need for cost control, need for flexibility and change, etc. are the issues which contributed to outsourcing non-core activities of an organisation.

Shortage of critical skills, changing practices, global competitiveness and need for cost control are the issues which contributed to outsourcing non-core activities.

BPO & HRO

The process of development of BPO and HRO, as an extension of SCM philosophy has been discussed from a historical perspective to appreciate its generic root. It is clear that over the years, the need for outsourcing was felt by the organisations both for economic and strategic compulsions. SCM, as a concept, though developed much later, now integrates the outsourcing also along with customer service, demand flow and distribution. BPO is the long-term contracting of a company's non-core business processes to an outside service provider. BPO paves the way for global competition and ensures strategic focus on core capabilities for improving stakeholders' value, efficiency and reducing operating costs. Identified benefits of BPO are: quality improvement, enhanced access to technology, lower operating costs, greater efficiency and strategic focus on core competencies. BPO covers activities like; finance and accounts, human resources, real estate related matters, internal audit, tax compliance, applications process, procurement, etc.

BPO is the long-term contracting of a company's non-core business processes to an outside service provider.

Within an organisation, a supply chain encompasses all functions. Every organisation decides its own strategies for all functional areas, like; accounting and finance, human resources, information technology, etc. Such functional strategies are integrated with supply chain strategies through a value chain. A strategic fit when ensured through a value chain, contributes to company's success. Proper mapping of customer requirements and matching the same to supply chain responsiveness and the functional strategies within the value chain help us to achieve the strategic fit. Major drivers in a supply chain strategy are; Inventory, Transportations, Facilities and Information. Responsiveness and efficiency of each driver determines the success of a supply chain.

SCM at the outset, emphasised networking among component manufactures, service providers and distributors. With IT interface, it has now assumed a broader perspective, leveraging competitive advantage for the organisations. Among others, SCM also helps in leveraging people by better use of human capital. BPO and HRO in that way are extensions of SCM, which institutionalised the outsourcing of non-core activities. Like employee leasing, BPO and HRO also offer the same advantage to small companies, without requiring them to invest unnecessarily in costly infrastructure. With simultaneous changes in the organisational structure, and redesigning organisation in line with the capability profile along with other changes concerning management practices and global economic environment, BPO and HRO are no longer confined within small business support services. With initial focus on call centers and medical transcription activities, it has now even been extended to expert knowledge services,

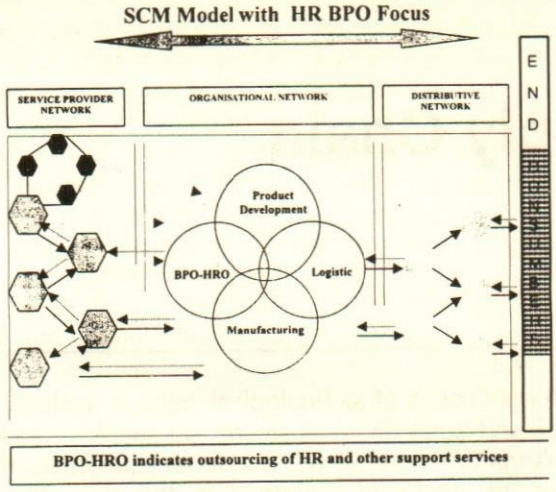

Fig. 1. SCM Model with HR BPO Focus

facilitating organisations to outsource their non-core activities, much more extensively, maintaining their focus on core manufacturing, product management or marketing. The onus of identifying core and non-core activities lies within the organisation. Examination may be a core activity for an educational organisation, while admission may be a non-core activity, which can be outsourced. This, however, may not hold good for all. Some private players in education may consider both examination and admission as non-core and outsource it, by limiting their focus only on product (course-ware) development. The concept of educational franchisee, revolves around this philosophy. Similarly manufacturing may be a non-core activity for an organisation, while product development marketing may be their core activity. There are many FMCG players who follow this model. An integrated SCM Model with HR BPO focus is presented in Fig. 1.

After an organisation decides about outsourcing, in the next phase, it is important for them to select the right vendors. Depending on customer expectations, vendors can be benchmarked on quality, price, delivery and service parameters based on market information, duly assigning weight for each factor. Presently there are only handful of players in India in BPO market with employee strength as high as 12000 (GE, Gurgaon and Hyderabad) to as little as 25 (ii Accounts, Bangalore). But with the increase of global market in BPO from $208 billion in 1999 to $543 billion in 2004, as predicted by Gartrer Group, more players are likely to crowd this sector. What is more likely is that major IT giants like; Wipro, Infosys, Tata Consultancy Services (TCS), HCL Technologies, IBM Satyam all joining the BPO bandwagon, redefining their business focus. With the passage of time, even management consultants will make a foray into this segment, giving wide opportunities to organisations to bargain for the best in terms of price, and quality. PwC, Accenture, Exult, Arthur Andersen, Loyds ISB are already in this business in a limited way. In BPO, HRO is a new accession, which makes a traditional HR Department in an organisation redundant. HRO initially started with payroll administration, but today it encompasses all HR functions. Gartner Group, for HRO alone, predicted a global business of $ 12 billion by 2003 from its present volume of $975 million (1999). Although outsourcing HR is still widely debated and there exists wide difference of opinions about its core or non-core characteristics, big giants are increasingly switching over to HR BPO, realising its potentiality beyond cost control. Exult, the international pioneer in HR BPO already roped in Bank of America, International Papers. BP Amoco and over the years predicts to spread their business in most of the fortune 500 companies. With humble beginning in leasing, outsourcing now has become a global activity with reinforced SCM. □

> Opportunity is missed by most people because it is dressed in overalls and looks like work.
>
> **– Thomas Edison**

The Mobile Wireless Supply Chain

Hemant Kumar Sabat

As mobile wireless unfolds, the business world looks for an assessment of technical and competitive landscape, high return on investment opportunities, sweet spots in the supply chain, and value propositions of the industry. This requires an understanding of mobile wireless supply chain. This paper delineates value propositions that the mobile wireless supply chain is evolving to offer. Then, it describes elements of the evolving supply chain to help the business world deliver on the full promise of mobile wireless.

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A confluence of technological leaps in devices, networks, and applications is setting the stage for wireless to change our lives the way Personal Computers (PCs) did in the 1980s and Internet in the late 1990s. A measured approach to service adoption and pricing yields just the annual U.S. industry revenues of nearly US$15 billion in five years, and US$60 billion in ten years (Lundberg & Zucker, 2000). The mobile wireless business represents an opportunity size that is enough to make the business world tremble.

Stakeholders investing in mobile wireless have to assess a wide landscape of technical and competitive issues. Mobile wireless entrepreneurs have to understand the meaning and structure of the entire mobile wireless supply chain in order to identify the potential sweet spots. Investors have to understand the sources of high returns in the mobile wireless supply chain to identify opportunities for investment. The user must understand the value proposition of the available mobile wireless services to subscribe to. Further, customer perception of mobile wireless value decides the success of the offering of telecommunications industry.

Business value proposition

The success of the mobile wireless supply chain is hinged on whether the chain meets customer perception of mobile wireless value. The mobile wireless subscribers want a convenient, secure, reliable and personalized service—at a value-based price. Subscribers expect 'anytime, anywhere' Internet access (capturing the concept of mobility—ubiquity and 'reachability' or 'always on') coupled with a user-friendly interface (physically convenient).

Further, mobile wireless content offers a value proposition different from that of wireline content. Mobile wireless will not be used for Web surfing, where the experience is about creating user's own course along a trail of page views. On the contrary, the mobile Internet will be more for hunting. Subscribers expect individually defined services—driven by personal choice

and location-sensitivity. Wireless Application Protocol[1] (WAP)-enabled mobile handsets promise real-time location information using global positioning technology. In addition, devices are to be designed to help the customers build their own processes to reflect the way they run their life, rather than having the form factors and processes imposed on them. Cost incentives will be necessary to persuade users to upgrade their devices as new functionality becomes available.

The subscribers expect individually defined services—driven by personal choice and location-sensitivity.

To offer value-based generic services, along with premium specialized ones, niche players with core competence in business operations will emerge. Finally, customers demand a guarantee that data and payments sent via mobile commerce will not be accessed by unauthorized parties and that the transaction is reliable. Security over the mobile network will be superior to that in today's fixed Internet environment. This is mainly due to Secure Socket Layer[2] (SSL) technology and the Subscriber Identification Module[3] (SIM) smartcard.

The challenge mobile wireless supply chain now faces is how to meet these expectations. While analyzing the stupendous success of NTT DoCoMo's i-Mode in Japan, it is apparent that a confluence of business strategies helped i-Mode wireless service to successfully deliver the mobile wireless value. NTT DoCoMo took appropriate steps to market i-Mode (the right marketing model), had the benefit of an all-packet digital wireless network in which to deliver it (the right technology model), priced the service aggressively (the right customer model), ensured that massive amounts of content would be available to users (the right content model), ensured that the terminal vendors provided technology-compatible, customer-oriented handsets (the right device model), and struck a balance between an open, Internet–like environment and a portal of partners with which it has business relationships (the right application development model) (Rendon, 2001).

These aspect can be understood further by looking at how the mobile wireless supply chain has been evolving to deliver the four mobile wireless value propositions—convenient, secure, reliable, personalized service at a value-based price—to the wireless subscriber.

Mobile wireless supply chain has to deliver the four mobile wireless value propositions—convenient, secure, reliable, personalized service at a value-based price—to the subscriber.

The mobile wireless supply chain

In mobile wireless industry, like other industries, there is a fundamental split in business models among customer-facing and support services, and the underlying communications networks and ownership of spectrum rights to offer wireless services. This division

Network operation—"Wholesaling" by network operator	Wireless services provision—"Retailing" by Service Provider
• Acquires spectrum rights	• Resells airtime
• Buys exclusive infrastructure asset from wireless infrastructure equipment suppliers	• Acquires and manages the customer relationship
• Builds and manages a wireless network	• Sales and marketing
• Sells capacity on the network on a wholesale basis	• Pricing
• Guarantees QOS levels	• Activation
• Upgrades/expands to meet service needs	• Fulfillment
• Brokers application services onto network	• Advanced services
	• Customer support
	• Manages relationship with content-related services and applications
	• Offers mobile network services to the subscriber

Fig. 1. The wholesaling and retailing functions in mobile wireless value chain

1. An application environment and a set of communication protocols for wireless devices that are designed to enable manufacturer-, vendor-, and technology-independent access to the Internet and advanced telephony services. In 1997, WAP Forum was formed by Ericsson, Nokia, Motorola and Unwired Planet, which rebranded itself as Phone.com, to define an industry-wide specification for developing applications over wireless communications networks.
2. A protocol developed by Netscape for transmitting private documents via the Internet. SSL works by using a private key to encrypt data that is transferred over the SSL connection. Both Netscape Navigator and Internet Explorer support SSL, and many Web sites use the protocol to obtain confidential user information, such as credit card numbers.
3. The size of a credit card, it has an embedded silicon chip that enables it to store data and communicate via a reader with a workstation or network. The chip also contains advanced security features that protect the card's data.

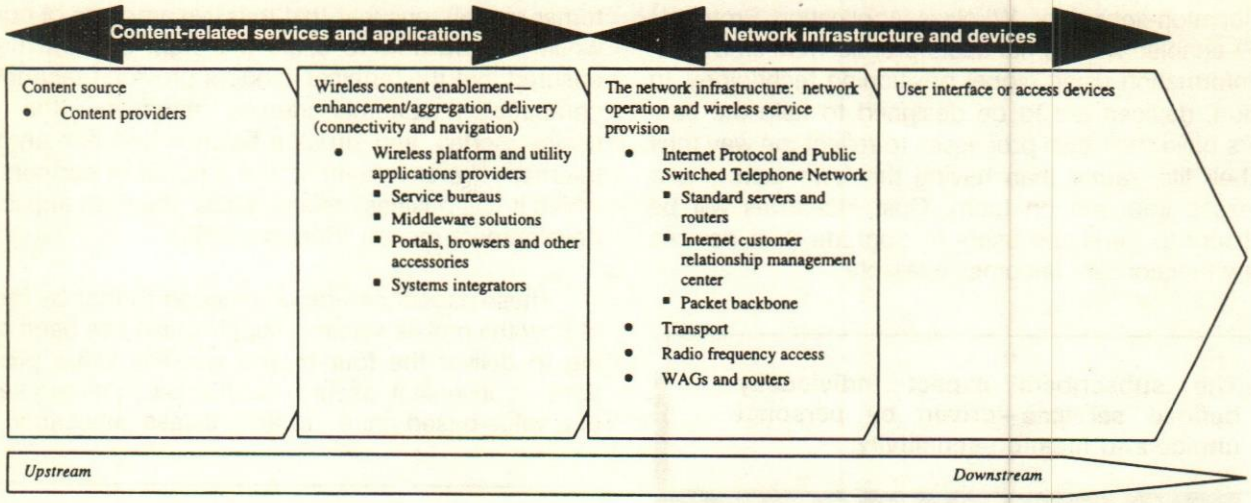

Fig. 2. The mobile wireless supply chain

of responsibilities is best placed in the context of wholesaler and retailer functions of mobile wireless supply chain (Fig. 1).

To discharge these functionalities, the value chain could employ competent players. The radio frequency spectrum licenses, which are required to offer wireless services, are auctioned by governments of the respective countries. Traditionally, the network operator bought rights to spectrum (spectrum owner role) to offer wireless service in a market, owned and managed the network (network operator role), and provisioned customer-facing wireless services (service provider[4] role). In sum, it managed and owned the entire supply chain.

The Internet revolution has sprouted new competitive forces, and a new economic environment wherein users now demand more numerous and powerful services and content. To meet these surging expectations, the supply chain must evolve to provide new content and services. For this, it must now incorporate new players, who have the expertise needed to implement specific mobile wireless services. Not only this, there are multitudes of elements in the chain and their interactions are complex. So, to deliver on the full promise of mobile wireless, the supply chain has been encouraging partnerships between wireless operators, service providers, equipment vendors, industry, service bureaus, systems integrators, terminal vendors, end-users and academia, among others. With each party bringing their expertise to the 'sandbox', creative, new services and applications can be offered in real-time, with reduced risk. In the new regime, then, the wireless network operator no longer owns the entire supply chain.

The supply chain has been encouraging partnerships between wireless operators, service providers, vendors, industry end-users and academia.

Fig. 2 describes the current evolutionary state of supply chain and its elements. While the segments of the supply chain have been fluid and could well be grouped in many ways in response to the dynamic landscape, this paper attempts to flesh out exactly what these different segments have been doing, who the players have been in the market, and how the companies have been creating value and generating revenues. The two broad elements of the supply chain are content-related services and applications, and network infrastructure and access devices. Content providers create mobile content suitable to be delivered via wireless portals. The content is carried through the network of the wireless network operators (e.g., telephone network operators like AT&T, NTT DoCoMo, Vodafone, etc.) and service provider (e.g., Internet Service Providers like Exodus, AOL, etc.). Subscribers access the content through their mobile wireless devices.

Content-related services & applications

Content is the Holy Grail of mobile wireless. The content in the mobile wireless world can be mobile (but not wirelessly connected for synchronization with wireline content), wireless (but not mobile), or both

4. A direct provider of service, and not merely an entity that puts its content onto the services offered by carriers.

mobile and wirelessly connected. This segment of the supply chain includes the sources and types of mobile wireless content as well as content enhancement and delivery applications.

Content sources

Three content sources—traditional voice channels, and data channels (Internet and corporate intranets)—are driving the movement of wireline world content to the mobile wireless universe. Voice communications are the main content in traditional telephone network. Increasingly, voice channels are evolving to share the same backbone infrastructure with the emerging data channels. Increasingly, people are seeking out information through new channels (special Web sites, bookmarks, e-mail alerts) rather than traditional channels (print, radio, television). So, traditional content originators (news bureaus, magazines, entertainment networks, etc.) have established Web sites to gain an Internet outlet for their brands, which has created a mountain of content. Enterprise intranets are another wireless data pump. There are many wireline Internet content sources that have evolved in the U.S. that were (or are) destined to be wireless services. In Europe and Asia, lower PC penetration has seen such services launch straight to mobile phones on Short Message Service (SMS) or WAP, bypassing the wireline Internet altogether. Examples of such services include Citykey, Digital-bridges.com, Upoc, Indiqu, MobileID, Myalert.com, Pico-fun, Telespatial, Go2Online, Vindigo, Wcities.com, and Webraska.

Mobile wireless devices currently offer databases (CityGuide.com, MapQuest.com, Zagat.com, Yellowpages.com), transaction-based services (Fidelity, Charles Schwab, ticketmaster.com, eBay), entertainment services (mp3.com, ipulse), news information (Flight information VirtuallyThere.com, GetThere.com, Travelocity.com, The weather Channel, CNN.com and Reuters), among others.

Mobile wireless devices currently offer databases, transaction-based services, entertainment services, news and information.

Wireless network uses electromagnetic ratio waves to transmit content from the wired world through the air interface to the terminal device. How the wireless operators can harness business potential of the supply chain is best understood by analyzing the three independent dimensions of the transmitted content (signal) in a carrier's network. The dimensions are: forms of content (voice or text-graphics), type of network (dedicated access or shared access), and mode of transmission (continuous or pulses) and type of technology (generation). Fig. 3 is a visual description of these dimensions.

The content (Signal) can be in two forms: voice and text-graphics (data). Multi-media content is a suitable mix of the two. The content (signal) is carried through the network of a wireless network operator and a service provider. To transmit these content (signals) through the carrier's network, two types of networks are used: dedicated line (circuit-switched) and shared access (packet-switched) network. In the simplest terms, a circuit-switched connection is like dialing up your ISP from home over traditional copper phone lines, whereas a packet-switched connection is like having a cable modem or digital subscriber line (DSL) connection.

A circuit-switched network dedicates one full communications circuit open to the users—the sender and receiver—for the period of the call, providing those users with exclusive use of the circuit. By contrast, a packet network lets multiple users share the same network for transmission at the same time. It divides that into distinct chunks (packets) with unique identification label (code) and address prior to transmission. The network then juggles the information chunks sent by multiple users by efficiently packing the chunks in the same circuit even while keeping all of the information bits intact. Each packet is transmitted independently and reassembled by the receiver.

For the wireless carrier, packet networks offer multiples of network efficiency relative to circuit-switched data networks. Circuit-switched connections are very bandwidth-inefficient for the network operator because an entire voice channel is dedicated to the data connection whether the user is transmitting data or not. On the other hand, packet-switched connections allow a message to be broken into pieces and routed along unused network channels. So, packet switching is most efficient for short bursts of data. In addition, if a circuit-switched connection is lost, the entire process must be undertaken again; if a packet-switched connection is lost, only the data that did not get through is resent, and the entire message is reassembled at the end. The circuit-switched network tends to be slower because it requires extra dial-up and connection times. In fact, the circuit-switched networks require devices to dial a number, connect and log, while packet-switched networks are always on and provide virtually instantaneous access.

Further, the content can be either in continuous streams (analog) or pulses (digital). The common voice

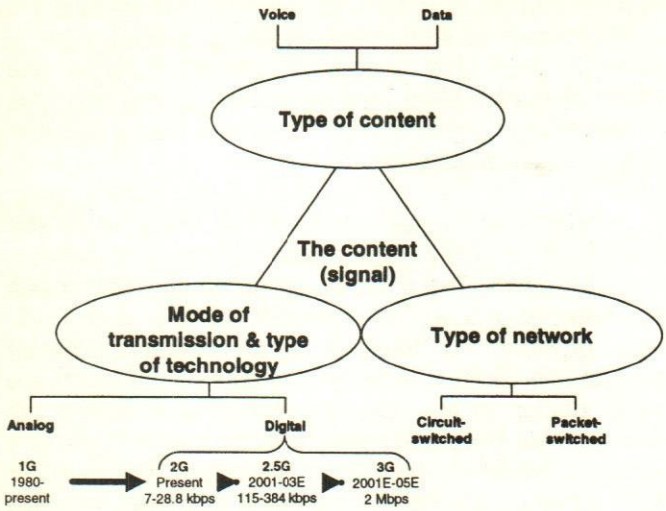

Fig. 3. The content (signal)

telephone network that is accessible to all customers with telephones and access privileges, also called Public Switched Telephone Network (PSTN), has been using analog mode to transmit signal. PSTN is based on "call connecting-disconnecting" (switching) technology to connect voice calls through a hierarchy of switching systems.

A deeper segmentation of mode of transmission leads to the type of technologies that are used to transmit the content. The original definitions for these technology types from the International Telecommunications Union (ITU) and its International Mobile Telecommunications Union (ITU) and its International Mobile Telecommunications (IMT)-2000 vision of technological generations in simple terms are as follows. First Generation (1G) Telecommunications technologies are the traditional analog cellular systems using Frequency Division Multiple Access (FDMA). (FDMA is a digital technology used to allocate discrete amounts of bandwidth to each user to permit many simultaneous users). The voice calls are connected and disconnected using circuit switches. Advanced Mobile Phone Service (AMPS) is the analog cellular telephone system. Second Generation (2G) systems are digital cellular technologies based upon Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) or Global System for Mobile Communications (GSM) over a Radio Frequency (RF) Channel. TDMA is a digital technology used to allocate multiple transmissions over a finite amount of spectrum by dividing the transmission into discrete time slots. CDMA is a spread spectrum digital technology that assigns a code to all speech bits, sends an encoded transmission, and reassembles the transmission upon reception. GSM is the standard digital cellular telephone service using the TDMA architecture. These systems enable maximum data transfer speeds of 9.6-14.4 kbps. The voice switching is done through digital circuit switches to offer Cellular and/or Personal Communications Services (PCS). PCS is a two-way, 1900 MHz digital voice, messaging and data service designed as the second generation of cellular. PCS coverage is more limited than cellular coverage, and building penetration is lower, due to the shorter wavelength. Personal Digital Cellular (PDC) is Japan's second generation or digital cellular technology.

The 2.5G solutions, which are digital cellular systems, offer maximum data transfer rates up to 384 kbps. These are based on introduction of a packet overlay network on top of the existing 2G digital circuit switch-based voice networks. For voice transmission, the architecture and process remain unchanged; the overlay kicks in for data transmission in packet mode. For example, General Packet Radio Service (GPRS) is built as an overlay on top of existing GSM network infrastructure and requires new network elements at the mobile switching center and the base station controller. GPRS promises data rates of 54 kbps to 174 kbps as well as continuous Internet access that does not require a dial-up connection. CDMA2000 1×RTT (Radio Transmission Technology) is a competing technology of this generation that offers data rates up to 153.6 kbps; its Release A version aims to peak at 307 kbps.

Third Generation (3G) systems are digital cellular technologies wherein both voice and data switching are done using packet switches, and with data transfer rates greater than 384 kbps. This is because these systems transmit data at higher rates using larger 'pipes' (higher spectrum bandwidth). Technology belonging to this generation are: CDMA2000 1×EV-DO (Enhanced Voice-Data Only), CDMA2000 1×EV-DV (Data-Voice), and Universal Mobile Telecommunications System's or UMTS' Wideband-CDMA (W-CDMA).

In its simplest form, each of these mobile network generations provides radio access into the existing fixed telephone network. Fundamentally, the mobile wireless architecture consists of five parts: mobile Core Network, mobile Radio Access Network (RAN), Operation and Support System (OSS), Mobile Terminal (MT) or Mobile Station (MS), and the backhaul (see Fig. 4). The Core Network connects the RAN to fixed network. The Core Network consists of a switching system and gateways, and the RAN consists of a Base Station System (BSS).

The switching system performs the call routing (direct a call to a specified location), switching (connect and disconnect calls), call control, charging, and accounting functions. It also performs a few supplementary services such as call forwarding and call barring through the Intelligent Network (IN) platforms, which

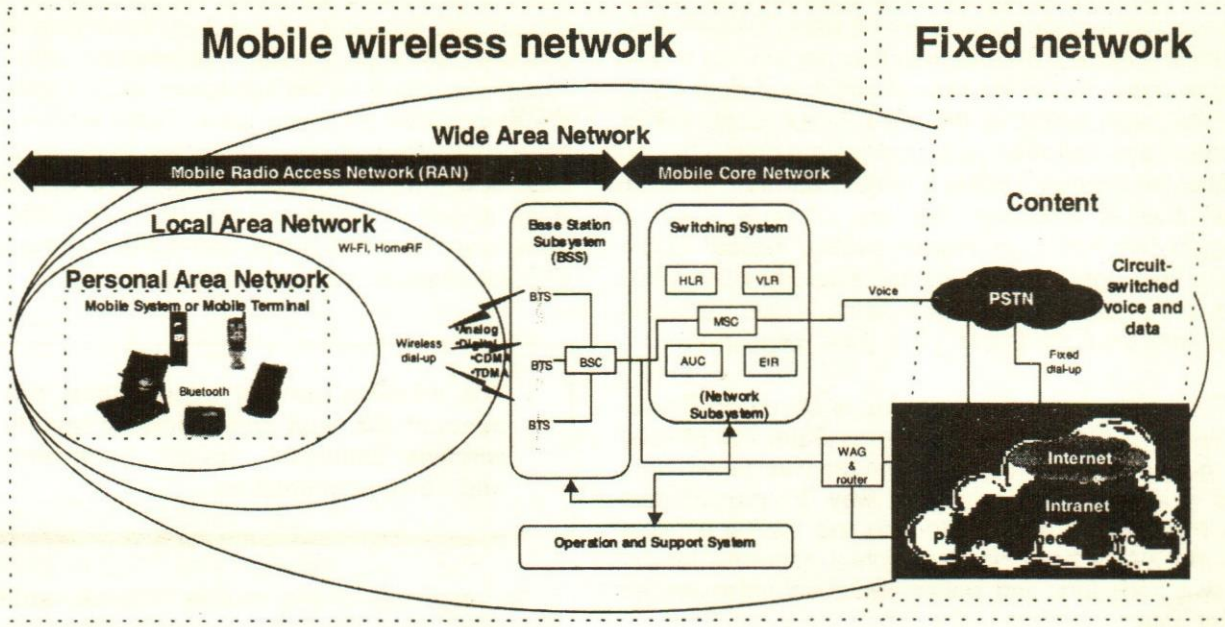

Fig. 4. Wireless network layers (WAN, LAN, PAN), Intranet, Internet, traditional telephone network (PSTN)

provides service creation and control features. The IN enables roaming between different networks, voice-mail services, billing services, prepaid roaming services, fraud control, and customized value added services. The switching system comprises of Mobile Switching Center (MSC), Home Location Register (HLR), Visitor Location Register (VLR), Authentication Center (AUC), and Equipment Identity Register (EIR). The MSC sets up calls, connects various elements of the switching system, and interfaces/controls calls to and from other telephone and data systems like the PSTN. It registers a user with the home location so that features such as messaging and so on can be provided when the user is not at home. It holds the intelligence and uses this subscriber information to recognize a user, register the user and collect information to provide billing. The HLR, connected to MSC, is a database that is a permanent storage of subscriber services and current location information of subscribers. It helps manage subscriptions and service profiles. When a subscriber visits from another wireless carrier's (or wireless service provider's) network, the MSC uses a database called VLR to service the visiting subscriber. This database contains temporary information about visiting subscribers while within the range covered by a specific MSC. The AUC is a database containing an authentication register of all subscribers. It minimizes fraud by allowing only authorized users access to the mobile network. The EIR holds information about mobile terminals, which allows an MSC to check with the EIR to stop faulty or stolen terminals from being activated on the network.

The BSS consists of Base Station Controllers (BSCs) and Base Transceiver Stations (BTSs). The BSC performs all radio-related functions efficiently to allocate radio resources to the different mobile subscribers (called radio resource management). determines when a handoff between base stations is required (when a mobile subscriber moves between cells), and controls the transmitted power of a terminal (handset) to ensure that it is sufficient to reach its service base station. BSCs are also the connection between the mobile terminal and the MSC.

Essentially, the BTS involves a number of radios that offer geographical coverage and traffic-handling capacity in a surrounding radius (or cell). Other associated BTS infrastructure spending includes the microwave link for cell interconnection, and a number of other items not necessarily supplied directly by the equipment vendors (Salomon Smith Barney, 2001): cell site container, antenna installation, and tower costs (materials, installation, site preparation). The BTS organizes and manages the radio interface by transmitting and receiving signals from the subscriber's terminal and houses the radio transceivers that define a cell. The BTS also handles the radio link protocols with the MTs, and provides exclusive access to a band of radio spectrum. Thus, the BSS interfaces between the switching system and MTs.

The MS is the wireless device through which subscribers receive and send mobile services like voice and data calls. The MS includes the mobile handsets. In the GSM/UMTS networks, it includes SIM card as well. The OSS manages the whole network and all network elements from a central point, handling system and cell

network planning as well as traffic statistics. The operations and maintenance center can be within the switching system and/or the BSS. The backhaul portion of a mobile network refers to the transfer of voice and data traffic from the base station to the base station controller or between base stations if base stations are daisy-chained together for example, along a major freeway. There are three physical mediums that are primarily used to transport this traffic: microware radios, leased T-1/E-1 lines or fiber optic cable. A T-1 line supports 1.544 Mbps while a T-3 line handles 44.7 Mbps. Their European counterparts are the E-1 and E-3 lines, respectively.

The wireless network signaling is based on Signaling System 7 (SS7). Wireless Access Gateways (WAGs) and routers bring the content from the wireline world to users in a mobile-device-friendly way. To transmit data from the wireline data world into the mobile wireless network, WAGs have circuit-switched gateways for circuit-switched data and packet-switched gateways for packet data.

The network architecture of a wireless carrier that has been described so far, and that is commonly referred to today is wireless Wide Area Network (wireless WAN). A wireless WAN is a wide area data transmission over mobile wireless network. Other wireless networks, by geographical coverage but in unlicensed spectrum bands, are wireless Local Area Networks (wireless LANs) and wireless Personal Area Networks (wireless PANs). Wireless LANs are a lower-radius layer well-suited for deployment within an office building, a campus environment, or a home to give users freedom of movement with constant connectivity to a network. It is a flexible, on-premise data transfer and communication system, which generally acts as an extension of or complement to wireline LAN (generally made of twisted pair, coaxial cable) within a building or campus. A fixed LAN is a combination of hardware and software technology that allows computers to share a variety of resources such as: printers and other peripheral devices, data, application programs or storage devices. LANs also allow messages to be sent between attached computers, thereby enabling users to work together electronically in a process often referred to as collaborative computing. In general, LANs are confined to an area no larger than a single building or a small group of buildings. A wireless PAN typically covers the few feet surrounding a user's work space and provides the ability to synchronize computers, transfer files, and gain access to local peripherals.

Mobile wireless content enablement—enhancement/ aggregation, delivery (including connectivity and navigation)

While the content in the wireline world and the wireless world remains the same, the wireless content suit should take into account the dual constraints of mobile wireless universe: limited bandwidth and device capabilities (form factor, resolution, etc.). Three players are responsible for these tasks. While mobile wireless service providers give a user access to the mobile wireless content through networks, content enablement services (based on applications) determine what a user does when they are online, and content providers provide personalized content to the user.

The wireless content should take into account the dual constraints of mobile wireless universe: limited bandwidth and device capabilities.

In response to the mobile wireless architectural challenges, operators are investing in higher generation technologies, such as 3G, to optimize transmission with limited spectrum availability. Mobile service providers, on their part, have been responding to the challenges by adding WAGs to their networks (Figure 4). As mobile wireless devices become ubiquitous, the content providers will have to create new niches in the device market and leverage their brand popularity to position themselves. This will help them create "stickiness" (drive repeat visits) to wireless portal sites. Content providers and mobile wireless service providers seek help of content enablers to adapt the content to a rapidly expanding mobile subscriber base on multiple devices and air interfaces.

To enable optimized offerings through the available bandwidth in the network, content enablers use conversion tools to create portals that deliver content suitable to mobile wireless devices. These content enablers develop wireless platforms and utility applications to give users access to content from the wireline world.

Some of the content is 'enhanced' through aggregators (which portray it with other content) or applications (which break through firewalls, etc.) and /or used in conjunction with other 'enhancers', such as location or voice-enabled services to make the user experience more friendly. The content then gets delivered. Content delivery involves making the user experience such a positive one that the user becomes addicted to wireless data and thus uses it even more. Wireless synchronization services allow all of the devices to wirelessly sync with desktop, calendar, contents and documents. Optimization services speed up the delivery of information to users. Security services ensure that the credit card used in m-commerce transactions will not be

used for fraudulent purposes and that enterprise firewalls are protected when enterprises wirelessly enable their employees.

In the evolving mobile wireless phase, data services have come into being in two primary market segments: vertical and horizontal. Vertical markets refer to industry-specific applications and services that are generally highly customized for the industry in question. Horizontal markets refer to applications and services whose utility is common to many industries, or whose purpose is to serve the mass consumer market. Generally, horizontal markets include all mobile professionals and consumer mobile Internet users. The four main purposes of horizontal wireless services are basic communications (voice, messaging), accessing or sharing data and information (personal, business), media & entertainment (video, audio), and engaging in commercial transactions (purchases, sales). Mobile wireless content enablers serving the two markets are described below under four categories: service bureaus, middleware/content delivery applications, portals and systems integrators.

Four purposes of horizontal wireless services are basic communications accessing or sharing data and information media & entertainment and engaging in commercial transactions.

Service bureaus

Service bureaus develop open platforms that convert and format all types of data information into communications services that can be delivered to any kind of terminal. These companies enable wireless service providers to offer their subscribers access to Internet services, as well as next generation messaging, electronic commerce, and information services. By deploying flexible billing and customizable multilingual content and applications, service bureaus enable wireless service providers tailor their offerings to the subscribers' preferences—when the subscribers want, where they want, to whatever mobile device they choose. Thus, these features offer carriers and service providers true flexibility, reduce time-to-market their products as well as reduce operational risks. Service bureaus link the subscriber to content and services provided by the wireless portal by taking a content provider's Application Program Interface (API) and performing all the necessary integration and customization. Further, these companies have relationships with a number of popular Web sites and sell access to this relationship to the carriers. Some also offer organisational tools, such as calenders, contacts, and alert services (Table 1). To illustrate the business utility of mobile wireless content enablement services, two categories of such services—messaging, and mobile wireless advertising—are as follows:

(i) Messaging services: The lowest common denominator of wireless data is messaging service. Basic numeric paging evolved into one-way alphanumeric paging, or text messaging. SMS is generally limited to 160 characters and is available in one-way form to the device from most digital cellular operators. Two-way SMS service allows the handset itself to compose and send a message. Mobile e-mail allows in the neighborhood of 1,000 characters. Instant Messaging (IM) takes the attractive aspects of mobile e-mail as a communications tool, but eliminates most of the network delay created by Internet routing bottlenecks. IM is based fundamentally on a closed system where a user can only send an IM to another user on the same network. Unified Messaging promises to simplify these delivery formats into an integrated product that delivers a single message across all these formats. An intelligent unified messaging platform that is coupled with dynamic synchronization of devices (fixed and mobile wireless) can actively route a single message to the most appropriate form for a user's current location and reception capability.

Location-based applications are valuable for emergency assistance purposes. Voice-enabling technologies translate text into speech, provide voice recognition, translation and dictation that helps a mobile user listen to the e-mail message.

(ii) Mobile wireless advertising: Three distinct mobile wireless advertising models could unfold:

- Broadcast advertising to the entire user base
- Advertising targeted to specific location or demographic area
- Electronic Yellow Page (EYP) advertising targeted in response to customer queries

The successful models will recognize that wireless, unlike other media distribution channel, has enormous rewards such as location, reachability and 'always on', but significant risks such as the deficiency of credible measurement. The placement of a message can be so much more targeted and relevant, especially by combining attributes of the Internet and wireless, such that an advertiser can know a user's movement both in terms of online actions and mobile location. The advertiser may also know exactly who they are reaching if

customers "opt in" to receive advertising and release their specific personal location information. Examples of mobile wireless advertising enablers are Spotcast and Profilium. Spotcast has leased its advertising technology to SmartTone and PeoplesTel in Singapore (Johnston, 2000). Profilium aims to deliver advertising relevant to users' interests and location by combining imprecise location information with user profiles and broader demographic and psychographic data. It is targeting ad agencies and infrastructure equipment suppliers like Ericsson and Lucent (Yokomizo, 2001). Ultimately, increased bandwidth should enable advertisers to deploy their current traditional media campaigns into the wireless space.

Middleware/content delivery applications

Middleware products operate between the application logic and the underlying physical network to support distributed computing environments. By providing a critical link between the wireless device, the underlying network and the content, middleware facilitate the transmission of content from wireless portals through filtering (resolution reduction, palette translation), compression, and content re-purposing (i.e. protocol conversion Hyper-Text Markup Language or HTML to Wireless Markup Language or WML). Middleware provides security; accommodates different networks, operating systems, and data formats; provides transactional support; and accesses often-incompatible data sources. Currently, commercial middleware services are synchronization, data optimization and security applications (Table 1).

(i) Synchronization services: Synchronization allows subscribers to sync mobile data (e-mail, calendars, to-do lists, contacts, key data, etc.) across a variety of devices and programs, should there be a change on any of one's devices.

(ii) Data optimization services: Transmitting data across cellular wireless networks is still a difficult proposition. One, the bandwidth constraint on wireless networks do not support transmission of large amounts of data. Two, wireless connections are still unreliable. The need to jam-pack the network with information to transmit data from the wireline world to the wireless device has created a market for optimization services (Bruzesse, 2001). The first order of business is reduce the size of the data being transmitted (called compression). Using advanced data compression algorithms, data optimization software compacts the chunks of text and data content. Built to operate over wireline networks, Web servers and browsers typically accompany their data packages with a welter of descriptive and error-correction information. Optimization software strips away all but the most essential bits of data (called streamlining). In the final stage, called caching, the optimization client predicts which information will be reused and then retains as much of that data as possible on the target device. These services may include additional features, such as improved handling of interrupted data sessions.

(iii) Security applications: The emergence of wireless data is creating demand for reliable security. Enterprises need to authenticate employees before granting them wireless access to their corporate e-mail. Mobile commerce users need to encrypt card information.

Portals

An Internet portal is defined as a network site that aggregates, presents, navigates, and delivers a wide range of Internet communication, commerce, and content services to a large number of visitors. Popular portals, such as Yahoo or AOL, are distinguished from traditional Internet sites because they are designed to serve a large number of users or visitors (millions per day) with a significant amount of usage (page views). Portals employ various 'usage-driver' services, like provide value-added services, to keep visitors on the site longer and lure them to return more frequently. Thus, 'usage-driver' features convert the click-through traffic volumes generated by many search engines into stay-and-play visitors. Value-added services might include free news, EYPs, email, chat, personalized content, financial services, on-line shopping areas, and community and Internet access.

An Internet portal is defined as a network site that aggregates, presents, navigates, and delivers a wide range of Internet communication, commerce, and content services to a large number of visitors.

Wireless portals build on the Internet's existing communications and commerce strengths to intelligently deliver content to a variety of portable end-user devices. The portal may generate the content itself or use content from alternate content providers. The content needs to be reformatted for the wireless world and some of the services that can be offered include unified messaging, and mobile e-commerce (Table 1).

Table 1: Content enablement companies

Content enablement activity	Companies
Content enhancement	
Aggregators	AvantGo, InfoSpace (Saraide), i3Mobile, Oracle Mobile
Consumer applications	Visto.com, Comverse Technologies, PocketScience, Opengrid
Mobile e-mail	Research in Motion (Blackberry), OmniSky, and Go-America
Instant Messaging	AOL, Microsoft's ICQ, and Yahoo!
Enterprise applications	Netmorf, Thin Air Apps, MobileSys, Infowave, WirelessKnowledge (Qualcomm[5]), Spotcast, Mobile Logic
Mobile advertising applications	Profilium, Spotcast
Wireless ASPs	Air2Web, Everypath, Aether Systems, 724 Solutions
Wireless device operating systems	Palm, Research In Motion, Phoine.com (UP.Link), Stinger (Microsoft)
Wireless portals	
i. Wired-to-wireless portals	America Online, Yahoo!, MSN, Excite, CNN Mobile, Lycos NTT DoCoMo's i-Mode
ii. Wireless network operator portals	America: AT & T Wireless (PocketNet), Nextel (Online), Sprint PCS (Wireless Web), Verizon (Mobile Web), VoiceStream (Infostream), BellSouth, Bell Mobility, Motient, SBC, Metricom [Phone.com (UP.Link Server Suite)] Europe: iobox, MyAlert, Vizzavi, Zed (Sonera), Vodafone, Orange Asia: NTT DoCoMo, KDDI, J-Phone
iii. Independent Wireless portals	GoAmerica, OmniSky, Palm.net, Shadowpack, GiantBear, Spyonit Mobile, Yodlee2Go
iv. MVNOs	Virgin Mobile
Financial services	Aether Systems, 724 Solutions
Education services	Mindsurf (Sylvan Learning Systems-Aether Systems), Symbol Technologies
Automotive services	WingCast (Ford-Qualcomm), GM's OnStar
Gaming services	Bertmart, Nintendo, Psone (Sony), Digital Bridges, Red Jade
Location-based services	Webraska, Cellpoint, US Wireless, Airflash.com, CT Motion, XY Point, SignalSoft
Voice-enabled services	Talk2, Nuance
Content delivery	
Synchronization services	WebSync, InfoSpace (Saraide), FusionOne, PointBase
Optimization services	Bluekite.com, GoAhead, BroadCloud, XOSoft, Fourelle, Idetic, JEDI Technologies, 4thpass
Security services	Brokat, Verisign, Baltimore
System integrators	IBM, Critical Path, Oracle, and Computer Associates

5. In early November 2001, Microsoft gave up its 50% stake in WirelessKnowledge to Qualcomm thereby the latter owning the venture.

Systems Integrators

Some operators may benefit by outsourcing to, or partnering with, a systems integrator. A systems integrator is a specialist in the development of an end-to-end wireless Internet offering. Such alliances may be particularly appropriate for turnkey wireless solutions, and for smaller operators with less data experience. By offering proven expertise in back office, customer care, billing and other value chain elements, these companies offer a way for operators to differentiate themselves in a highly competitive market, where time-to-market is critical.

Table 1 lists the companies that provide content enablement applications.

Network infrastructure and access devices

The downstream operations of mobile wireless supply chain include management of wireless network, provisioning of wireless services, and development of devices for subscribers to access the mobile wireless content.

The network infrastructure: network operation and wireless services provision

The growing mobile wireless market demands both voice and data communication services. Voice and data can be offered through both circuit-switched and packet-switched network of multi-media service providers, and through either PSTN or Internet Protocol (IP)-based network. It is a telecommunications protocol for communication across digital networks. It is the key enabling technology of the Internet as it is the most widely used agreement for internetworking. It is free, open public specification.

As wireless data services flourish, and the volume of IP traffic grows, the industry will see a true confluence of

wireless and Internet. With this technological leap, today's wireless networks will migrate to a new king of architecture called wireless Internet packet-based network (WIPN)—one that is secure, reliable, scaleable, manageable, and fully IP-optimized. The WIPN architecture consists of packet-based core network infrastructure optimized for an IP applications architecture. This involves an evolution to a common-packet architecture for voice and data traffic with distributed access, transport, routing/switching, and control functions. Services—including voice, data, mobility management, and new IP services—will migrate to server platforms. Voice traffic will be carried in packet format from end-to-end. By doing so, voice and data will be consolidated into a single network. As network data traffic increases, these changes will drive a reduction in the number of physical network elements and links, as well as a reduction in warehousing facilities. The net effect will be a reduction in network operator's costs for voice traffic and quicker time-to-market for new services and applications even while optimizing the network for data end-to-end. The industry will then realize the benefits of scope economies.

The five key value chain elements needed to implement a WIPN are: a packetized network backbone, an IP standard server architecture, an Intranet customer relationship management center, WAGs and routers, and wideband radio interface.

The five key value chain elements needed to implement a WIPN are: a packetized network backbone, an IP standard server architecture, an Intranet customer relationship management center, WAGs and routers, and wideband radio interface. Table 2 lists a few of the network infrastructure suppliers and wireless network operators.

The mobile wireless network elements are as follows:

Packetized backbone transformation

End-to-end transport of voice payload in packetized format will drive a reduction in network elements and links. This change will also free network capacity for the deployment of new revenue-generating data services. The emergence of packet-driven networks will improve operational efficiencies, reduce costs and boost overall profit margins. To secure these benefits, service providers will migrate to network designs that deliver a single, consistent network architecture for voice and data communications. Circuit gateways, called Inter-Working Function (IWF), which transmit circuit-switched data into mobile wireless network, will help today's circuit-based network using time division multiplexed traf-

Table 2: The network operation and wireless services provision companies

Network infrastructure	Companies
Core network equipments	
Routers and nodes	3Com, Cambia, Cisco, Lucent, Nortel, Sun, Symmetry, Tahoe, WaterCove
MSCs	Alcatel, Cisco, Ericsson, Motorola, Nokia, Nortel, Sun Microsystems, Tellabs, Winphoria, Lucent, Spatial Wireless
Servers, storage	Most major OEMs, ADC, CMG Telecom, Compaq, EMC, Hewlett Packard, IBM, Linux, Oracle, Sema, Sun Microsystems, Tellabs
WAG and routers	Cisco Systems, Sun Solaris-Phone.com gateways, Juniper, 3Com
Radio access components	
Base Stations	Agere, Alpha Ind, Anaren, Agilent, Infineon, MCE, MorphICs, National Semiconductors, Qualcomm, Stanford MicroDevices, Texas Instruments, Xilinx, Motorola WJ comm
MMW radios and components	Alcatel, Alvarion, Ceragon, DMC Stratex, Endwave,Ericsson, Hughes
BTS and BSC sub-assemblies	Anaren, Andrew Corp, Allen Telecom, Arraycom, Flarion, mDiversity, Metawave, Powerwave, Remec, Spectrian, Wireless Online
Full-up BTS and BSC	Nortel, Alcatel, Ericsson, Siemens, Nokia, Samsung, Motorola, Lucent
Wireless modems	Novatel Wireless, Sierra Wireless
Wireless ASICs	Motorola, Qualcomm, Texas Instruments, Nokia, Ericsson, NEC, Siemens
Network operators and wireless service providers	Bharti, Batata, Reliance Telecom, Singapore Telecom, Telstra, SK Telecom, Korea Telecom, Chunghwa Telecom, Taiwan Cellular, CSL, Pacific Century Cyberworks, Japan Telecom, AT&T Wireless, Sprint, Nextel, Cingular, China Unicom, China Mobile, NTT DoCoMo, Hutchison, Vodafone, British Telecom, Verizon, Deutsche Telekom, Orange, Telia, SFR, Bouygues, Telefonica Moviles, Telefonica Moviles, Telecom Italia Mobile, Sonera, Tele Danmark, America Movil, BellSouth International, Bell Canada, ALLTEL, US Cellular, VoiceStream
Transport	Nortel Networks, Ciena, Ciena, Cisco Systems, ONI Systems, Redback Networks, Corning, Corvis, Lucent
Tower and cell site	American Towar, Crown Castle, 02wireless, Wireless Facil, SBA Communications, SpectraSite Communications, Pinnacle Holdings, SOFRER (France), RaiWay (Italy)

fic evolve to a packet-based network (using IP and Asynchronous Transfer Mode or ATM). ATM is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic.

IP services Internet

An open applications and services architecture will enable wireless operators to harness the power of Moore's Law. That is the power of a chip doubles every eighteen months, the cost of the chip remaining constant. This architecture will facilitate migration of new services development and control functions to IP-based, commercially standardized server platforms. Voice/HLR/mobility servers will perform the functions of traditional MSCs, saving on maintenance and other costs. New data IP services—such as email, personal communications portals, hosted applications, Intranet access—will be easily deployed in the wireless environment to create new market opportunities and business models. The IP services intranet will also enable seamless delivery of new services and connectivity to the Internet, portals and service bureaus.

Intranet customer relationship management center

By implementing flexible Internet-style back-office systems, and by consolidating services and management functions over MANs and WANs, operators will realize additional operational and maintenance cost savings. This back-office will feature advanced, carrier-scale IP subscriber services management, optimized network management, new opportunities in billing, server administration, and data mining and enhanced customer service for voice and data. By using embedded Quality of Service (QoS) capabilities to provision Service Level Agreements (SLAs) with key customer segments, a carrier can install flexible pricing systems for differentiated services. Service providers and carriers can charge a value-based price for generic services, and charge a premium on high-end services.

Transport

The transport story thus far has been: from copper-based wires through opto-electrical Synchronized Optical Network (SONET) systems to evolving all-optical fiber transport. Since the 1980s, telecommunications companies have deposited 283 million miles of optical cable into the ground, according to fiber-optic consultancy KMI Corp. That cable powers phone networks and the Internet, enabling most of the high-speed communications in the Information Age. In 2000, sales increased by a phenomenal 40 per cent, largely due to Internet boom (Kharif, 2001). Through all- optical fiber transport, carriers can transmit signal over longer distances without significant transmission losses. Further, optical fibers can transmit more traffic than the traditional copper wires (coaxial cables, etc.). Carriers will, thus, realize operational and maintenance cost savings even while benefiting from secure transport of voice and data.

Wireless Access Gateways and routers

Wireless Internet differs from the wireline internet arena in significant characteristics, such as mobility and extremely limited bandwidth. By contrast to voice traffic, the data traffic flows through specialized routing hardware until it reaches the core packet networks. In addition, the WAP communication protocol, developed to bridge the gap between the Internet and cell phones, requires a gateway specifically designed to serve content to cell phones. A WAG sits at the crossroads of broadband wireline Internet and narrowband WAP-based wireless networks to solve interoperability issues among various terrestrial wireless networks (Fig. 4). It helps adapt these networks to the Internet. While serving as the interface between the base stations and the new packetized backbone, WAGs handle responsibilities such as IP addressing and data compression. As mobile wireless unfolds, WAGs consolidate functions traditionally performed by the BSC and circuit gateway (IWF)/packet gateway onto a packet-based platform. By securely connecting the content source to the wireless network, WAGs facilitate reliable transfer of data between protocols and operating systems. It optimizes the content for the device being used, and enhances data packets for faster throughput over the network. This increases capacity and improves throughput in a mobile wireless environment. Thus, WAGs improve service providers' profit margins through better operating efficiencies and by reducing costs.

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User interfaces or access devices

Subscribers use mobile wireless devices to access the wireless content that the network offers. Based on the Internet model, the wireless device contains a micro-browser—a display screen—to view the content, while the content and applications are hosted on Web

servers. As wireless products proliferate and services differentiate in the market, a wide range of terminals and devices are now being produced to support mobile wireless services and applications. While the number and variety of these devices continue to grow, a true 'killer device' is yet to emerge that can offer multiple functionalities/benefits.

As wireless products proliferate and services differentiate, a true 'killer device' is yet to emerge that can offer multiple functionalities/benefits.

Nokia with 33.4 per cent market share, Motorola with 15.7 per cent, Ericsson with 8 per cent, and Samsung with 7.3 per cent are leading handset suppliers in mobile wireless industry. LG Electronics, Korea's second largest handset maker, ranks eighth with 3.1 per cent market share (Newlands, 2001). Table 3 lists the players in the handset supply chain.

Table 3: The handset supply chain industry

Handset supply chain	Handset supply chain elements	Companies
Demand side	Core network equipment	Nokia, Motorola, Sony-Ericsson, Samsung, LG Electronics, Alcatel, Toshiba, NEC, Matsushita, Mitsubishi, Siemens, Sanyo, Sendo, Kyocera
Supply side	Electronic manufactures services	Celestica, Elcoteq Arima, Solectron, Flextronics
	Components	Infineon, Triquint, Murata, ST Micro, RF Microdevices, Kyocera, Philips, Atmel, Toyo Comm, EPCOS, Cypress Corp., Tokyo Denpa, Qualcomm, Matsushita Electric, Texas Instruments, Alps Electric

The mobile wireless solutions

Various solutions have been emerging – some are already commercial – along the supply chain to deliver the promised value to the mobile wireless subscriber. The mobile wireless matrix in Fig. 5 categorizes emerging solutions by the forms the content exists in a user interface device, the location of the terminal device, and the mode of connection of the device with the content source in the wireline world. As stated earlier, the content in the mobile wireless world can be mobile (but not wirelessly connected for synchronization with wireline content), wireless (but not mobile), or both mobile and wirelessly connected. Evidently, mobile wireless content is converging with the wireline Internet, which is referred to as the mobile Internet. The traditional communications (e.g., telephone lines) and fixed computing facilities (e.g., fixed, or wireline Local Area Networks, or LANs) fall in the fixed-wireline quadrant of the 2×2 matrix.

The mobile wireless quadrant covers wireless MANs and wireless WANs. A wireless MAN is a packet radio that covers a metropolitan area, and is often used for law-enforcement or utility applications. Unfortunately, the current wireless WAN systems are plagued by airwave spectrum bandwidth bottlenecks and yet-to-be-developed unified architectural standards and their enabling technologies. No wonder these systems involve costly infrastructures, provide much lower data rates, involve cross-carrier network roaming charges, and require users to pay for bandwidth on a time or usage basis.

Two other network layers in unlicensed spectrum bands, offering different geographical coverage, are becoming inextricably tied to the WAN. These are wireless local service gateways – wireless LANs and wireless PANs – that fall in the fixed-wireless quadrant of the 2×2 matrix.

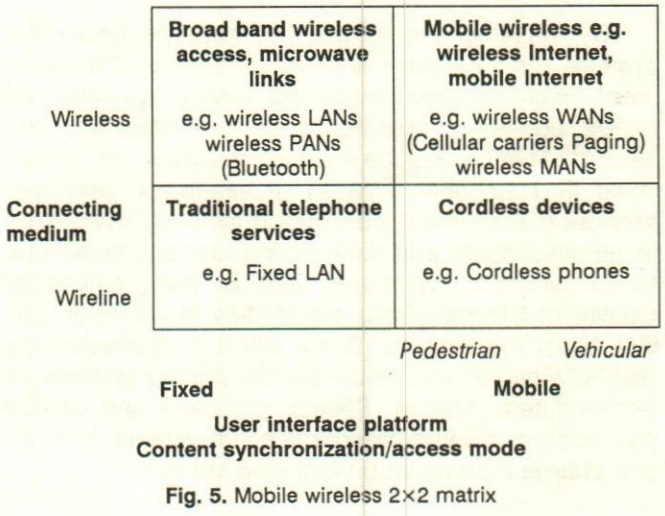
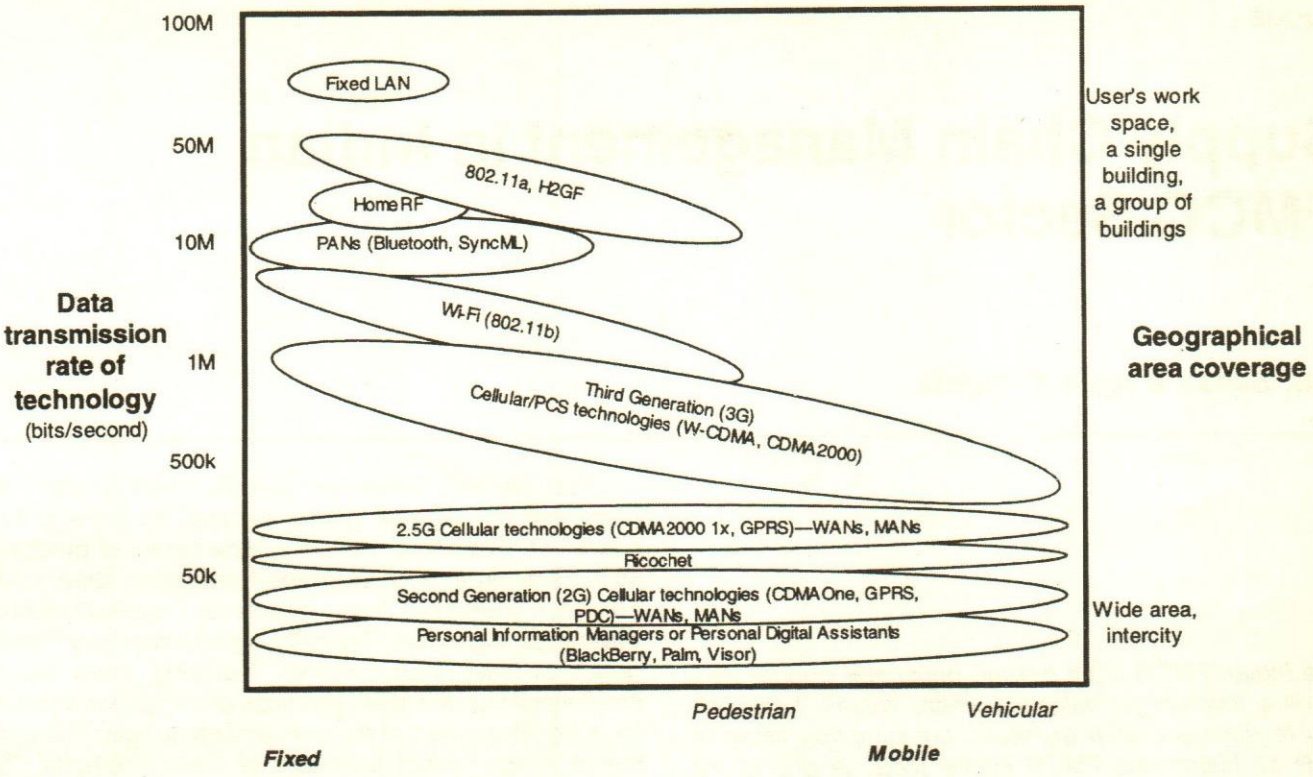


Fig. 5. Mobile wireless 2×2 matrix

Several technologies offer mobile wireless access to data, in general, and in particular, to wireless Internet. Currently, these solutions are provided in conjunction with mobile voice services using cellular/PCS technologies (CDMA, TDMA, GSM, PDC, etc.), and standalone data channel services like Ricochet (wireless modems), Research In Motion's two-way pagers (BlackBerry), wireless PAN technologies (Bluetooth, SyncML). The data transmission rate of each of these wireless data access technologies, and the types of environment (user interface device) they operate in could vary. As shown in Fig. 6, the user interface platforms could be either sta-



Note: W-CDMA: Wideband Code Division Multiple Access H2GF: HiperLAN2 Global Forum

Fig. 6. Comparison of wireless data access technologies

tionary/fixed or mobile. Further, the terminal devices could be moving at walking speed or vehicular mobility speeds while synchronizing with the content source.

There is an additional dimension: the geographical area covered by the system solutions could vary too. Technologies supporting higher data transmission rates cover smaller geographical areas, e.g., wireless and fixed LANs. On the other hand, technologies that can transmit over large geographical areas support lower transmission rates, e.g., today's Wireless carrier's cellular networks, or wireless WANs. This trade-off is a result of airwave (electromagnetic wave) signal deterioration due to interference and attenuation during transmission.

Conclusions

Customers' perception of mobile wireless value will decide the success of mobile wireless industry. The industry aims to deliver this value through a supply chain. As the supply chain delivers on its full promise of ubiquity, reachability and 'always on' capability, the mobile wireless subscribers' hitherto unmet sweet spot will be satisfied. The fully-evolved supply chain will serve customers with integrated functionalities of information, entertainment, communications and computing features. However, the challenges from spectrum bandwidth scarcity, network reliability and investment economics loom large. Telecommunications infrastructure capital investment patterns and wireless subscriber penetration life cycle, which are twin-components of mobile wireless economics, will lead the growth of the industry.

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Supply Chain Management in Indian FMCG Sector

B.S. Sahay & Arun K. Gupta

The Indian FMCG (Fast moving consumer goods) sector is a low-margin business where volume holds the key to success. With domestic consumption close to USD 17 billion, the FMCG sector today is one of the largest in the country and accounts for about 14.5 per cent of the GDP. In the current scenario of global slowdown, increasing uncertainty in demand and supply, changing customer preferences, and shortening of product life cycle besides rigorous competition from multinational companies, this sector has been forced to reconfigure its supply chain strategy for survival and growth. The present paper traces the development and trends of supply chain management practices followed by FMCG sector in India and suggests ways to perfect it in order to remain competitive.

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Fast Moving Consumer Goods (FMCG) refers to consumer non-durable goods required for daily or frequent use. The sector covers a wide gamut of products such as detergents, toilet soaps, toothpaste, shampoos, creams, powders, food products, confectioneries, beverages, cigarettes. Typically, a consumer buys these goods at least once a month. Individual items are of small value but all FMCG products put together account for a significant part of the consumer's budget. The consumer keeps limited inventory of these products, (as many of these products are perishable) and prefers to purchase them frequently, as and when required. The consumer spends little time on the purchase decision and rarely does he/she look for technical specifications (in contrast to industrial goods). As most of the demand is due to requirement purchase decisions may be influenced by the availability of product.

In FMCG sector, one of the most critical success factors is the ability to build, develop, and maintain a robust distribution network. Availability near the consumer is vital for wider penetration as most products are low unit value products and frequently purchased. Out of reach is out of mind is out of consideration set. Distribution network refers to the consumer buying points where products are available (almost always). It takes enormous time and effort to not only build a chain of stockists, retailers, dealers etc but also improving upon their efficiency and effectiveness. In a transforming economy, loyalty of customer and channel partner to the product is of concern for the organisations. This presents a very complex situation to manage. Moreover

In FMCG sector, the most critical success factor is the ability to maintain a robust distribution network. Avail-ability near consumer is vital for wider penetration.

the current slowdown is preventing dealers/retailers to allocate resources and time. Therefore it is necessary to clearly visualise and implement an unequivocal supply chain strategy, which addresses the concern of upstream and downstream partners and is able to provide a win-win situation for all.

Indian Market Perspective

At the time of independence, MNCs were allowed to operate in India, but the Indian market was too small to attract the global MNCs. In the early '60s, several MNCs set up manufacturing base in the country. The government policies continued to be protective modelled on socialistic pattern with strong emphasis on self-sufficiency. Consequently economic growth was slow (around 3.5 per cent (p.a) which many economists dubbed as Hindu rate of growth) and India's share in international trade was nominal (even today India's share in international trade is only 0.6 per cent). Slow growth was aggravated by major setbacks in the late 60's due to drought and in the early 70's due to oil shock.

Foreign exchange crisis in 1991 (precipitated by Kuwait war) proved to be a blessing in disguise, due to which IMF-suggested reform process began. The reforms have continued over the last few years. After privatisation and globalisation efforts of the government of India since 1991, business all of a sudden has become customer focused. Customers, having choices have become more demanding. The situation has led to a real explosion of the list of products and services offered, with considerable repercussions on the entire supply chain. All the operation processes of the company, from management of customer order to distribution and up to scheduling of production and purchase have become victims of this proliferation, with a stunning rise in operating costs and a gradual inadequacy of the little range of service offered and virtually no customer care set-ups.

With average economic growth rate of 5-6 per cent year and a consistent rise in demand and purchasing power of Indian market, FMCG market is likely to grow by 4-5 per cent per year in mature categories and 8-10 per cent per year in upcoming categories. However, factors such as low rural penetration, poor monsoon showers, price sensitivity of consumers and increased competition could result in decreasing profit margins in the industry. Emerging markets present a mix of future opportunities as well as new rivals. Information networks and technological convergence are re-defining the rules of economic and trading relationships within the country. Hence it is imperative for organisations to look into their strategies, product line and competitive advantages to sustain a fair growth in the current slowdown.

Indian business in the previously monopolistic regime was governed by cost sensitive factors. There is still hardly any appreciation for the concept of working along with the right business partners (suppliers, customers and service providers), fostering trust between them and designing the right system to deliver value to the customer. And the statistics show it all. The Indian FMCG sector spends an exceptionally high amount of over 15 per cent of its revenue on logistics. Close to 25 per cent of the aggregate sales, amounting to over $4.1b US, is tied up in inventories in the supply chain network countrywide. This 4 week-finished goods inventory is a major challenge to the organisations. To succeed today and in the future, this sector needs to create strong linkages with business partners using the concept of supply chain management.

Indian FMCG sector spends an exceptionally high amount on logistics.

Research Objectives

This research study emerged out of the need felt by managers, professionals and academicians to address supply chain issues at the national level. The first step in the entire exercise was not only to trace the reasons for such high levels of inventories and logistics cost, but also to gauge the current status of supply chain management practices in Indian industry. Hence, a joint research by Management Development Institute, Gurgaon and KPMG India was undertaken with the following objectives:

- To know the current practices of Supply Chain Management followed in Indian organisations.
- To identify and develop appropriate measures for Supply Chain Management processes and performance indicators.
- To undertake a cross-cultural comparison with select countries (US, Europe, Canada and Asia).
- To provide a benchmark for Indian companies looking to optimise their Supply Chain Operations.
- To identify the drivers of enhanced Supply Chain performance.

Supply Chain Costs in FMCG Sector

The total cost structure varies considerably across sectors. FMCG sector, which has higher volume and vast network characteristics ranks the highest in cost of material and logistics activities. Undoubtedly, this is primarily the result of the usage of highly critical and technology intensive components by the industry (Table 1). On an average, transportation costs (inbound, outbound and secondary/tertiary) account for 6.7 per cent of the total supply chain cost. Storage & Warehousing cost, which accounts for 3.86 per cent of the gross sales, follows closely behind. Table 1 gives a clear picture of the various components of supply chain costs and their total share in the gross sales of Indian FMCG industry.

Table 1: Supply Chain Costs (as a Percentage of Gross Sales)

Supply Chain Cost Type	Average	Cost in FMCG Sector Lower bound	Upper Bound
Cost of Material	52.92	15.00	90
Cost of Labour	8.90	0.51	70
Cost of Production Overheads	11.78	0.50	40
Storage Cost	3.52	0.16	12
Inbound Transportation Cost	3.38	0.12	20
Outbound Transportation Cost	3.38	0.12	20
Warehousing Cost	2.06	0.10	8
Secondary/Tertiary Transportation Cost	2.02	0.20	10
Distributor Margin	6.35	0.10	20

In order to have a more detailed understanding of supply chain costs, it is important to estimate the capital blocked along the supply chain in the form of inventories – raw material, work-in-process and finished goods. Capital blocked is also a measure of the responsiveness of the supply chain to market demand. The inventory, expressed in terms of number of days of sales, at any point of time determines the time taken to introduce a new product in market and hence indicates the number of days the firm is removed from the market. In the language of supply chain, this is known as the Time-to-Market and is expressed in terms of the average number of days of inventory in the entire supply chain – from supplier's supplier to customer's customer.

Capital blocked is a measure of the responsiveness of the supply chain to market demand.

On an average, Indian FMCG companies carry a total of 26.09 days of inventories as raw material and 4.4 days as WIP. The 6.0 days of GIT, along with 13.24 days of Finished Goods, reflect the poor state of supply chain infrastructure within the country. Simple operational initiatives viz. Inter-modal transportation, cross- docking, FTL movements could go a long way in reducing this component of supply chain inventories (Table 2).

Another very important parameter to determine the efficiency of supply chain is the inventory turnover. It indicates the velocity of goods i.e. the speed with which goods move and are replenished in the system. All other things being equal, a higher inventory turnover is preferred, indicating that the inventory moves through the firm's operations quickly, rather than being held for an extensive period. An increase in inventory turnover has a direct influence on the working capital management, resulting in an increase in the profitability of the firm. Table 2 reveals that the Indian industry, on an average, maintains an inventory turnover of 10.9 turns for raw materials and 24.7 turns for finished goods.

Table 2: Inventory (in units of Number of Days of Gross Sales)

Inventory	Average	Overall Lower bound	Upper Bound
Raw Material	26.09	3.00	60.00
Packing Material	22.50	5.00	45.00
Work in Progress	4.40	1.00	10.00
Finished Goods	13.25	2.00	29.00
Goods in Transit	6.00	4.00	7.00
Accounts Receivables	15.91	4.00	40.00
Accounts Payables	31.11	10.00	74.00
Inventory at CFAs/DCSs	10.72	2.00	20.00
Inventory at Distributors	12.67	4.00	30.00
Inventory at Retailers	14.11	2.00	45.00

Besides monitoring the supply chain costs and supply chain inventories, detailed in Table 1 and 2, some Indian organisations use standard/activity cost measures to manage the supply chain function. Among these measures, customer service cost of stock outs, order expediting cost and standard order processing cost are widely used by majority of the respondents.

Supply Chain Strategy

By elevating supply chain management to the heart of decision-making in the boardroom, and uniting cor-

porate and supply chain goals, companies can boost profitability and growth and substantially increase shareholder value. The challenge is to take supply chain to a more strategic level within the firm, and not just to content with managing it, Strategy represents the overall actions or approach to be taken to achieve the firm's goals and business objectives.

All the organisations were asked to prioritise their business objectives on a 5-point scale, with a score of 1 indicating "not important" and a score of 5 indicating "very important". These strategic objectives included maximising profits, turnover, return on investment, earning per share, value to shareholders and customer satisfaction. Table 3 provides the weighted scores for importance of various objectives to their business:

Table 3: Importance of Overall Business Objectives

Overall Business Objectives	Weighted Score the Importance
To Deliver highest value to shareholders	4.92
To Maximise Customer Satisfaction	4.83
To Increase earning per share	4.42
To Increase Return on Investment	4.33
To Maximise Profit	3.92

It is heartening to note that objective to deliver highest value to shareholders and increasing customer satisfaction has surpassed objective of maximising profit or increasing sales turnover. Companies have realised that short-term profit-making does not lead to accomplishing long-term growth and profit maximisation and hence have taken customer satisfaction on priority. Companies give low rank to increasing Earning Per Share (EPS), as EPS may be affected by short-term fluctuations (gains and losses) in the stock price, which becomes real profit or loss only if the stock is sold by the stockholder.

Today's business world is defined by change. Externally, there are powerful and global competitors, influential customers demanding more complex and varied services at less cost, and the increasing implications of mergers and acquisitions. Internally, there are stockholders requiring a constant increase in returns. The future success of an individual company depends on its ability to weather and manage the forces of change. When a company finds itself struggling to maintain profit margins, a renewed focus on supply chain strategy becomes the optimal way.

Expanding Depth and Width of Distribution, Offering Broad Product line and Expanding Revenue are the prime focus of FMCG Industries in contrast to Enhancing customer service/satisfaction, profit and other objectives. At the same time, reducing lead-time, reducing transpiration cost and reducing inventory cost follow closely in terms of supply chain priorities. Undoubtedly, all the objectives stated are the most vital and basic criterion for any supply chain management strategy to produce tangible results, which is well understood by the top management. Improvement in these metrics have a direct effect on the bottomline of the organisation (Fig. 1).

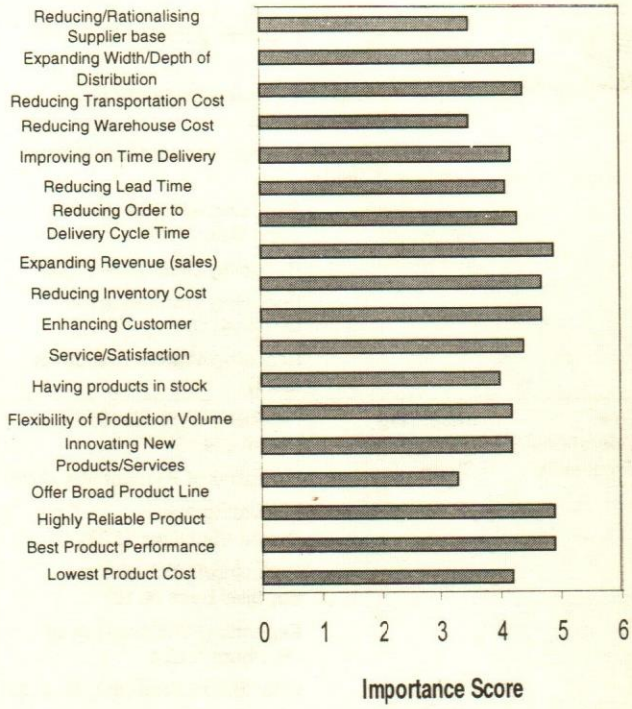

Fig. 1. Importance of Supply Chain Objective to Top Management

Further the weighted scores of various supply chain objectives were analysed and grouped by their level of importance. The scores on supply chain objectives were then compared to scores on business objectives. The business objectives and supply chain objectives could be broadly classified under three focal areas as listed in Table 4.

Supply Chain Processes

In most of the organisations, supply chain management covers the processes of demand management, manufacturing planning and scheduling, inventory management, order processing and fulfilment, warehousing, transportation, distribution management, import/export management, product development, promotions planning, and customer service. Respondents were asked to evaluate the criticality of these supply chain processes on a 5-point scale. A one on the scale indicated "not critical"

Table 4: Mapping Supply Chain Objectives with Business Objectives

Focal Area	Business Objectives	Supply Chain Objectives
High: Customer Satisfaction	Maximising Customer Satisfaction	Enhancing Customer Service/Satisfaction (4.93)
		Highly Reliable Product (4.76)
		Best Product Performance (4.65)
		Improving On-time Delivery (4.53)
Medium: Profit Maximisation	Maximising Profit	Expanding Revenues (4.35)
	Delivering value to shareholder	Reducing Inventory Costs (4.53)
	Increasing turnover (Sales)	Lowest Product Cost (4.53)
	Increasing Return on Investment	Reducing order to delivery cycle time (4.13)
		Reducing Lead Time (4.24)
		Reducing Transportation Costs (4.00)
		Reducing Warehouse Costs (3.24)
Low: Operational Excellence	Increasing Earning Per Share	Flexibility of Production Volume (4.13)
		Flexibility of Product Mix (3.88)
		Innovating New Product/Services (3.33)
		Reducing/Rationalising Supplier Base (4.19)
		Expanding Width/Depth of Distribution (3.4)
		Offer Broad Product Line (3.27)
		Having Products in Stock (3.18)

and a score of five indicated "very critical" process for the organisation.

Table 5 presents a weighted score for criticality of supply chain processes (on a scale of 1-low to 5-high). Demand management ranks as the most critical process for the respondents, as many as 64.7 per cent rate it as being "very critical" to their supply chain strategy. Following closely are Distribution management, customer satisfaction, inventory management and manufacturing with over 40 per cent of the respondent base in each category classifying them as "most critical". Supply chain processes like customer service, demand management, inventory management and order processing/fulfilment show a sincere concern of Indian FMCG companies to improve customer service as well as their increasing understanding of the need to perfect customer-centric processes.

The focus on demand management is a testimony of the fact that the FMCG sector has realised that demand management is the key to achieving customer satisfaction without compromising on customer service, in order to deliver superior bottom line results. Surprisingly, warehousing and import/export management scores the lowest in terms of criticality amongst all the supply chain processes, a process which needs to be re-looked at because of the increasing importance of developing superior warehouse management systems to support distribution management systems.

Table 5: Criticality of Supply Chain Processes

Supply Chain Process	Criticality Score
Demand Management	4.50
Customer Service	4.38
Distribution Management	4.38
Inventory Management	4.23
Manufacturing	4.08
Order Processing/Fulfilment	4.00
Transportation	4.00
Product Development	3.69
Warehousing	3.69
Promotion Planning	3.62
Import Export Management	2.85

An analysis maps the various supply chain processes on a two dimensional matrix—primary focus of process (enter-prise v/s inter-prise) and level of interaction of the process (high v/s low (Fig. 2).

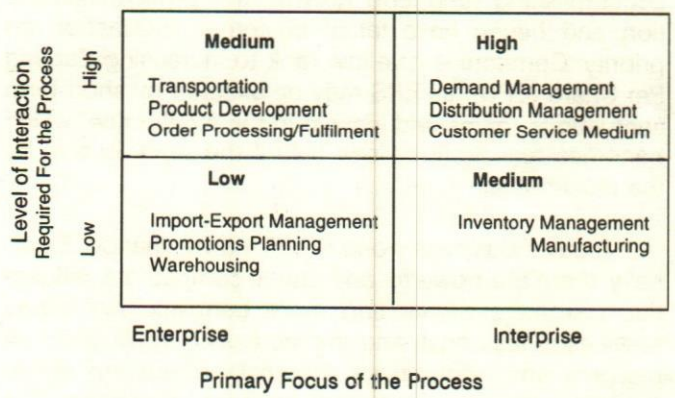

Fig. 2. Supply Chain Process Matrix

Enterprise covers processes which have a greater focus internal to the enterprise (e.g. Product Development, Manufacturing) while inter-prise covers processes having greater focus external to the enterprise i.e. oriented towards external stakeholders (e.g. demand management, customer service, distribution management). Interesting to note is the fact that processes that

relate to enterprise supply chain with low level of interaction with other processes come out as "less critical" whereas the ones that involve inter-enterprise interface or integration with high level of interaction with other processes as "highly critical".

Demand Forecasting & Management

In an ideal world, customer demand would be smooth and growing. As a result, demand would be perfectly predictable and therefore enable perfect planning of the supply chain for the least cost. Unfortunately, this is seldom the case. Uncertainty arising out of demand volatility necessitates inventory and complex forecasting to fulfil demand to the required level of customer satisfaction, (Bolton, 1995). Information leads to more effective forecasts. The more factors that predictions of future demand can take into account the more accurate these predictions can be. In order to have the true picture of consumer demand, supply chains are moving towards co-operative forecasting systems. This implies that all components of supply chain share and use the same forecasting tool leading to a decrease in the Bullwhip Effect (Simchi-Levi, 2000).

All components of supply chain share and use the same forecasting tool leading to a decrease in the Bullwhip Effect.

Collaborative methods are resorted to for carrying out business planning in most Indian organisations. To be precise, 53.33 per cent of the respondents state that business planning is done collaboratively by marketing, production and others in the organisation. This is a very healthy sign because it is the basic and the most important step to make the organisation process driven. Supply Chain Management being the basic process encompassing all the activities of demand management stands to benefit immensely from this collaborative planning initiative. It is noteworthy that business planning by marketing based on trends is still in practice by 33.33 per cent of the organisations (Fig. 3).

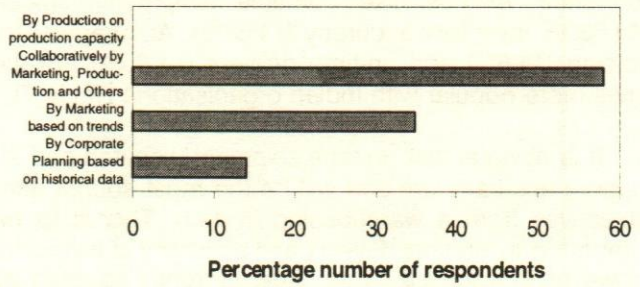

Fig. 3. Methods of Business Planning

Seasonality of Demand

A seasonal pattern is one that repeats at fixed intervals. This pattern could be observed daily, weekly, monthly or yearly. About 33.7 per cent indicated seasonality of demand in their businesses with end of calendar year (Oct-Dec) as the most common season (Fig. 4).

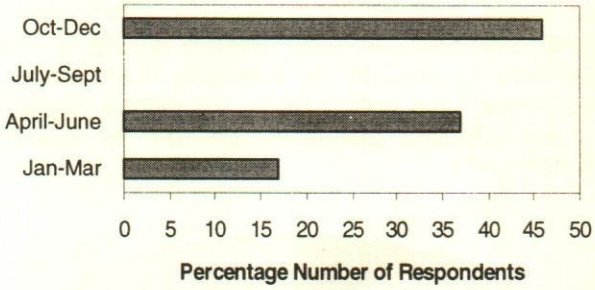

Fig. 4. Seasonality of Demand

However, seasonality is usually specific to an industry because of the products and the customer segment catered. Hence, a sectoral analysis shows that during seasons sales are accounted as high as 50 per cent of total sales. Table 6 provides percentage of sales in season.

Table 6: Percentage of Sales During Season

% of Sales in Season	% Respondents
50.00	2%
20.00	50.60%
20.00	60-75%
10.00	75.90%

Majority of respondents agree that extent of orders cancelled are less than 5 per cent of orders booked. As a result the stock returns from the field (as a percentage of sales) was less than 5 per cent from all the respondents.

Inventory Management

Management of inventory has received considerable attention over the years. Managers ascribe different reasons for holding or not holding inventory. Some of the major reasons for holding inventories are (Ballou 1978, Lambert 1993):

- To improve customer service
- To hedge against price changes and contingencies

- To achieve production, purchase and transportation economies
- To protect against demand and lead time uncertainties

Pull versus Push – inventory replenishment process

In a push-based system, production decisions are based on long term forecast. Typically, the manufacturer uses orders received form retailer's warehouses to forecast customer demand, thereby taking a much longer time to react to the changing marketplace. In order to make the system more responsive, organisations are adopting pull-based systems for inventory replenishment.

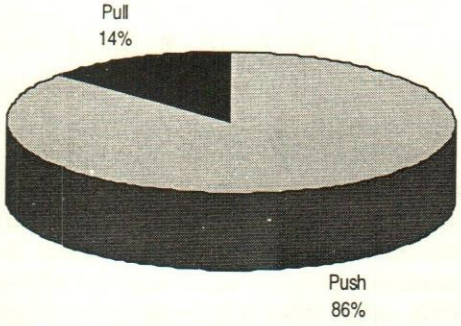

Fig. 5. Inventory Replenishment Policy

Globally, while pull based systems are being much talked about, 84 per cent of the respondents indicate use of push based inventory replenishment systems in India (Fig. 5). A few companies (16 per cent) have turned to pull based inventory replenishment process, where inventory is replenished by supplier, based on movement of product on the shelves and amount of inventory remaining. As a result inventory replenishment process in a pull-based system, in which production is demand driven, is co-ordinated with the actual customer demand.

84 per cent of the respondents indicate use of push based inventory replenishment systems in India.

Recent inventory management practices dictate achieving zero stock levels for finished goods and taking up of production against firm orders. However, citing the importance of inventory to FMCG sector no respondent indicated pure MTO (make to order) environment. 37.8 per cent indicate planning for finished goods inventory based on orders booked or existing order backlog and 27.4 per cent indicate planning for finished goods inventory based on manufacturing capacity (Fig. 6).

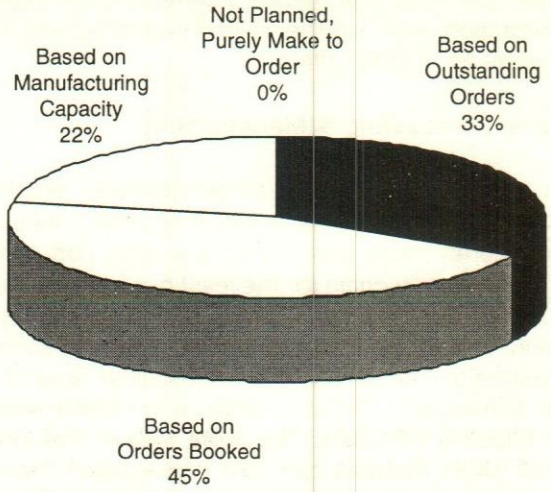

Fig. 6. Methods of Inventory Planning for Finished Goods

Warehousing & Distribution Management

One of the most important aspects of supply chain design is the selection of go-to-market strategy, i.e. the distribution channel. Traditionally, distribution channels, comprising intermediaries were developed with the primary objective of reducing the number of market contact points. Besides this, the intermediaries also took up the functions of sorting, accumulating, allocating, and assorting. Faced with growing complexity in customer preferences, trading partner dynamics, product line expansions and fresh options for interfacing with consumers, manufacturers have come up with innovative distribution channels as a tool for business success (Miller, 1998). The two widely used strategies are direct shipment and cross docking.

Warehouse Performance

A multitude of measures is employed by organisations to measure the performance of warehouses for higher efficiencies. Though warehousing is a widely outsourced activity, it is a healthy sign to note that, over 90 per cent of the respondents have measures in place to monitor their warehouse performance. Warehouse performance metrics like, on-time shipment/dispatch (14.63%), inventory accuracy (14.63%). Accuracy of invoicing (14.6%) and on-time delivery (14.63%) are the ones more popular with Indian organisations (Table 7).

It is obvious that on-time shipment/dispatch and inventory accuracy are and will be the most sought after objectives from a warehousing system. This is to be supported by on-time delivery and accuracy of invoicing. However, Warehouse Cycle Time, currently adopted by

a few, is a potential area of improvement of efficiency in distribution management. It is the difference between the time of receipt of order/indent at the warehouse and the time of dispatch of the same from the warehouse. It includes generation of Pick List, order picking, loading of items for shipment and then their subsequent dispatch.

Table 7: Measures for Warehouse Performance

Measure for Warehouse performance	% Respondents
On time Shipment/Dispatch	14.63
Inventory Accuracy	14.63
On time Delivery	2.44
Customer Complaints	2.44
Accuracy of Invoicing	14.63
Mismatch/Error in Dispatch	14.63
Stock Outs	7.32
Warehouse Cycle Time	9.76

Information Technology

Earlier, technology was imbibed into physical assets that offered efficient mass production of standard products. The emergence of the information era, which started in the last decades of the twentieth century, made obsolete many of the fundamental assumptions of industrial age competition. Consequently, organisations could no longer gain sustainable competitive advantage by merely deploying new technology into physical assets rapidly. The ability of an organisation to mobilise and exploit its intangible assets has become far more decisive than investing and managing physical, tangible assets. In an effort to provide increasing levels of customer satisfaction, the very nature of business is changing. Supply chain strategies are undergoing tremendous changes in response to these pressures created by the advent of Information Technology. Exciting technology-based approaches emerge almost daily. Many of these innovations are well suited to the enhancement of supply chain management, including Just-in-Time, Quick Response, Efficient Customer Response, and Continuous Replenishment. Regardless of the technology-based approach, all are attempts by businesses to manage activities across company boundaries in co-ordinated, integrated fashion (Handfield, 1999).

The ability of an organisation to mobilise and exploit its intangible assets has become far more decisive than managing physical assets.

IT Budget & Spending

Current levels of IT budget in the organisation are even less than 0.1 per cent of gross sales for 8.675 per cent of the respondents, 0.1 to 1 per cent of gross sales for 64.8 per cent and 3 to 5 per cent of gross sales for 18.4 per cent of the respondents. However organisations have planned for a major increase in their IT investment levels in the coming years. The level of IT budgets in the coming years are projected for .1 to 1 per cent and more of the gross sales for over 56 per cent of the respondents (Fig. 7).

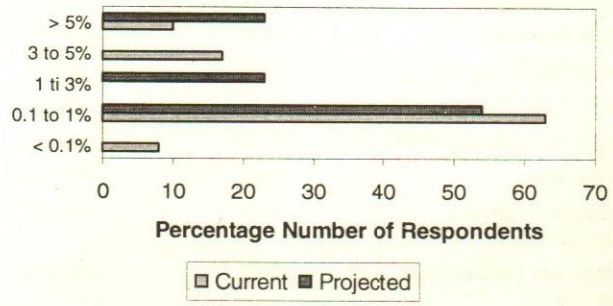

Fig. 7. Current and Projected level of IT Budget

IT solutions for Supply Chain

Operations covered by existing applications include inventory management, order fulfilment, warehouse management, sales returns, in that order. Existing IT solutions encompass the business operations covering Inventory Management, Order fulfilment, Warehouse Management and Sales Returns. All these areas are primarily restricted to the boundaries of the enterprise. Operations to be covered with proposed applications include bar coding, EDI with customers, EDI with suppliers, monitoring costs/performance, distribution network planning, freight cost management. Table 8 presents the coverage of various operations in the existing and proposed applications:

Proposed IT solutions show a clear shift to areas which involve networking with business partners and focus on logistics. The future areas of operations for IT solutions include facility Network Planning, Bar Coding,

Proposed IT solutions show a clear shift to areas which involve networking with business partners.

EDI with Carriers, Customers and Suppliers Freight Cost Management and Mobile Solutions being on the busi-

ness plans of as many as 70 per cent - 100 per cent of the respondents.

Table 8: Operations covered by Current and Proposed IT Applications

Operation	Covered in Existing Application (% Respondents)	Proposed Application (% Respondents)
EDI with Carriers	0.00	100.00
Facility Network Planning	0.00	100.00
EDI with Suppliers	0.00	100.00
EDI with Customers	0.00	100.00
Mobile Solutions	0.00	100.00
Bar Coding	12.50	87.50
Automatic Freight Payment	33.33	66.67
Freight Cost Management	33.33	66.67
Lot Tracking	40.00	60.00
Distribution Network Planning	44.44	55.56
Distribution Requirement Planning	44.44	55.56
Monitoring Costs/Performance	50.00	50.00
Warehouse Management	55.56	44.44
Inventory Management	62.50	37.50
Order Fulfilment	66.67	33.33
Sales Returns	66.67	33.33

Overall Business Performance

Overall business performance must be evaluated on the basis of process-based performance measures, function-based performance measures and QCDF performance metrics. The research lists the following five-performance metrics to gauge the effect of supply chain management practices on the overall business performance.

Table 9: Benefits for Companies that Implemented Supply Chain

Objective	Improvement
Sales Revenue Increased	10%
Profit Increased	15%
Order to Delivery Cycle Time Reduced	35%
Inventory Reduced	33%
Raw material	33%
Work-in-Progress	23%
Finished Goods	28%
On Time Delivery Improved	36%
Customer Base Increased	20%

Majority of organisations (46.4 per cent) cited integration of processes with suppliers and customers as the biggest benefit associated with supply chain integration, followed by reduction in cycle time (35.3 per cent), fundamental improvement through re-engineering (25.3 per cent) and improved productivity (14.6 per cent).

Respondents indicated extent of benefits on various indicators. An average across the respondents is indicated in Table 9.

Recommendations

Forecasting and Demand Management

As observed, error in demand forecasting in this sector is very high contributing to most of the supply chain inefficiencies. Hence there is a need for improving forecasting accuracy. Though it would be tempting to say that a pull system should be followed, it is not possible to follow an entirely pull system in this sector, considering the large volumes sold and the low value of items. A pure pull system would increase transportation cost considerably, and would not give business advantage. Hence, a combination of push and pull system is suggested for this sector.

Error in demand forecasting in this sector is very high contributing to most of the inefficiencies.

Inventory Management

In this system certain inventory is maintained at the retailers' end. As the consumer consumes the products the inventory at the retailer is replenished. Forecasting techniques are used to determine the inventory that is to be maintained at the retailers' end. The level of inventory is fixed in terms of number of days of inventory and the actual amount of inventory (in terms of numbers) keeps changing as per the forecasts. The inventory at the retailers is 14 days of sale and replenishment is in every 8.5 days. It means that they are carrying a safety stock of 5.5 days for a replenishment period of 8.5 days, which is around 40 per cent of stock. Usually, distance from factory to distributors is much more than distance between distributors and retailers. It is for this reason that in most cases replenishment time for distributors is higher than that of retailers. In the survey, a couple of exceptions to this phenomenon are observed (i.e. the replenishment period of distributors is lower than that of

retailers – This is probably because of absence of distributors in certain locations). If these exceptions are discarded, the replenishment period for retailers comes out to be around 6.65 days. Considering this, it is assumed that a replenishment period of 7 days for retailers is feasible even in the existing set-up. With a safety stock of 3 days, a stock level of 10 days could be maintained at the retailers. As distributors and factory are farther from the end consumer, and they also have greater time to react, the safety stock at the distributor can be low and it can be even lower at the factory. The regular stock is the expected demand during the replenishment period.

Warehousing and Distribution Management

The scene at the distributors is relatively better with them carrying 13 days of inventory for a replenishment of 10 days. Considering the fact that distributors, typically, are not very far from retailers, this is a certain area for improvement. The replenishment period can easily be reduced to atleast 7 days if not lesser. The second source of improvement is by introducing proper performance measurement system for warehouse operations. Surprisingly companies are not measuring their performance. This logistical lapse may put multiple geometric impact on performance of supply chain.

Information Technology

Organisations surveyed view IT as a strategic tool. But use of integrated systems that truly manage supply chain information are not yet commonplace in usage. Supply Chain Management solutions are used by only 30 per cent of the respondents. Discreet applications related to Materials Accounting, ERP, Sales & Distribution, and MRP II have wider applicability on date. But connectivity with supplier and customers through retailers and data collection direct from point of sales (PoS) is desirable for efficient and effective management of supply chain. PoS data helps organisations to directly know their demand and usage pattern. Moreover they come to know about the status of inventory across the channel, which helps them plan replenishment.

Conclusions

The supply chain management practices in Indian FMCG sector surveyed by the research do leave a ray of light. It clearly shows that corporate recognition of the importance of supply chain is growing rapidly. Over 80 per cent of the respondents have either undergone or were considering a review and redesign of existing supply chain network and management. These respondents estimate improvements/saving of over 30 per cent through this effort. These are huge savings for the Indian economy and will provide the necessary impetus in attaining a 7 per cent growth rate.

There is a lot of scope for improvement in the existing way of working of FMCG companies. With the present way of working itself, inventory of the system could be reduced by approximately 6 days (from 14 days to 10 days at retailer side, and from 13 days to 11 days at the distributors side). If third party logistics were used, inventories would further be reduced considerably, even though transportation costs might be slightly higher. Hence, there is a very good potential for improving supply chain efficiencies in the FMCG sector. Companies in this sector need to re-think their strategies and align with the chain partners to provide better customer service and gain business advantage.

Companies in this sector need to align with the chain partners to provide better customer service and gain business advantage.

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Model & Data Base Design

The data and model base design can be explained by a simple example as follows: Consider a supply chain system composed of two suppliers, two facilities, two warehouses and three customer centers as depicted in Fig. 1. Table 1 presents the symbols of related subscripts and sets. Table 2 is the data matrices required to be input by users. Table 3 denotes the decision variables in the models, where L represents level variable and R represents rate variable following System Dynamics (Forrester, 1961). The relationships among decision variables in Table 3 are illustrated in Fig. 5.

Table 1: Symbols of related subscripts and sets

Sets	Description	Subscripts	Description
V	a set of vendors	v	vendor
F	a set of facilities	f	facility
W	a set of warehouses	w	warehouse
C	a set of customers	c	customer
T	a set of time units	t	time period
P	a set of parts	p	part
G	a set of goods	g	goods

Table 2: Data required for user input

Data	Description
$Mcost_{tvp}$	material cost of material **p** supplied by vendor **v** at time **t**
$Pcost_{tfg}$	production costs of goods **g** produced by facility **f** at time **t**
VF_Tcost_{tvfp}	transportation cost of material **p** transported from vendor **v** to facility **f** at time **t**
FW_Tcost_{tfwg}	transportation cost of goods **g** transported from facility **f** to warehouse **w** at time **t**
WC_Tcost_{twcg}	transportation cost of goods **g** transported from warehouse **w** to customer **c** at time **t**
FM_Icost_{tfp}	inventory cost of material **p** of facilities **f** at time **t**
FG_Icost_{tfg}	inventory cost of goods **g** of facilities **f** at time **t**
W_Icost_{twg}	inventory cost of goods **g** of warehouse **w** at time **t**
ET_{vf}	lead time from supplier **v** to facility **f**
ET_{fw}	lead time from facility **f** to warehouse **w**
ET_{wc}	lead time from warehouse **w** to customer **c**
BOM_{gp}	amount of material **p** needed for producing goods **g** (bill of material)

The goal of this SCM 1.0 is to minimize the sum of related costs which are listed in the first eight items of Table 2, expressed as follows:

$$\text{Min} \sum_{t=1}^{5} \Big\{ \sum_{vp} Mcost_{tvp} * LV_{tvp} + \sum_{vjp} VF\_Tcost_{tvfp} * R_{tvfp} + \sum_{fg} Pcost_{tfg} * R_{tfg} + \sum_{jp} FM\_Icost_{tfp} * LF_{tfp} + \sum_{jg} FG\_Icost_{tfg} * LF_{tfg} + \sum_{wg} W\_Icost_{twg} * LW_{twg} + \sum_{fwg} FW\_Tcost_{tfwg} * R_{tfwg} + \sum_{wcg} WC\_Tcost_{twcg} * R_{twcg} \Big\}$$

subject to the following restrictions:

(1) upper-lower bound restrictions

$0 \le R_{tvfp} \le R_{tvfp}$ for all t, v, f, p

$0 \le R_{tfwg} \le R_{tfwg}$ for all t, f, w, g

$0 \le R_{twcg} \le R_{twcg}$ for all t, w, c, g

$R_{tfg} \le R_{tfg} \le R_{tfg}$ for all t, f, g

$LF_{tfp} \le LF_{tfp} \le LF_{tfp}$ for all t, f, p

$LF_{tfg} \le LF_{tfg} \le LF_{tfp}$ for all t, f, g

$LW_{twg} \le LW_{twg} \le LW_{twg}$ for all t, w, g

(2) flow conservative restrictions

$$\sum_{f} R_{tvfp} = LV_{tvp} \quad \text{for all t, v, p}$$

$$LF_{tfp} + \sum_{v} R_{(t-ET_{tw}\,wfp)} - \sum_{g} BOM_{gp}\, R_{tfg} = LF_{(t+1)fp} \quad \text{for all t, f, p}$$

Table 3: Decision variables in the model

Decision Variables	Description
LV_{tvp}	the amount of material **p** purchased by vendor **v** at time **t**
R_{tvfp}	the amount of material **p** which vendor **v** transported to facility **f** at time **t**
LF_{tfp}	the inventory of material **p** in the facility **f** at time **t**
R_{tfg}	the amount of goods **g** which facility **f** produced at time **t**
LF_{tfg}	the inventory of goods **g** in the facility **f** at time t
R_{tfwg}	the amount of goods **g** which facility **f** transported to warehouse **w** at time **t**
LW_{twg}	the inventory of goods **g** in the warehouse **w** at time **t**
R_{twcg}	the amount of goods **g** which warehouse **w** transported to customer **c** at time **t**
LC_{tcg}	the demand of goods **g** by customer **c** at time **t**

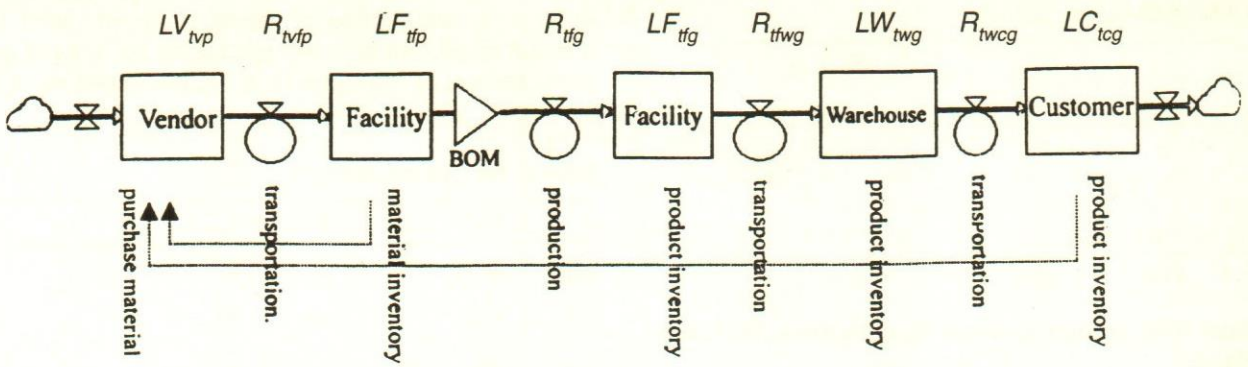

Fig. 5. Relationship among decision variables

$$LF_{rfg} + R_{tfg} - \sum_{w} R_{tfwg} = LF_{(t+1)fg} \quad \text{for all t, f, g}$$

$$LW_{twg} + \sum_{f} R_{(t-ET_{tw})fwg} - \sum_{c} R_{twcg} = LW_{(t+1)wg} \quad \text{for all t, w, g}$$

$$\sum_{w} R_{(t-ET_{wt})wcg} = LC_{tcg} \quad \text{for all t, c, g}$$

A Computer Company's SCM Plans

Now consider a notebook computer company AAA. Suppose AAA has two supplies (v = 1, 2), two facilities (f = 1, 2), two warehouses (w = 1, 2), three customers (c = 1, 2, 3), one goods (f = 1), three parts (p = 1, 2, 3) and 5 time periods (t = 1, 2, 3, 4, 5). All related data matrices corresponding to Table 2 are listed in Table 4.1 to Table 4.10.

Table 4.1: $Mcost_{tvp}$

Time	Vendor 1 v=1			Vendor 2 v=2		
	Part 1 p=1	Part 2 p=2	Part 3 p=3	Part 1 p=1	Part 2 p=2	Part 3 p=3
t = 1	10.5	6.5	8.5	20.5	7.5	7.5
t = 2	10.4	6.4	8.4	20.4	7.4	7.4
t = 3	10.3	6.3	8.3	20.3	7.3	7.3
t = 4	10.2	6.2	8.2	20.2	7.2	7.2
t = 5	10.1	6.1	8.1	20.1	7.1	7.1

Table 4.2 : VF_Tcost_{tvfp}

	Vendor 1 v=1	Vendor 2 v=2
Facility 1 f=1	0.01	0.01
Facility 2 f=2	0.01	0.01

Table 4.3: $Pcost_{tfg}$

Facility 1 f=1	Facility 2 f=2
0.4	0.45

Table 4.4: MF_lcost_{tfp}

Facility 1 f=1			Facility 2 f=2		
Part 1	Part 2	Part 3	Part 1	Part 2	Part 3
p=1	p=2	p=3	p=1	p=2	p=3
0.02	0.02	0.02	0.01	0.01	0.01

Table 4.5: FG_lcost_{tfg}

Facility 1 f=1	Facility 2 f=2
0.1	0.09

Table 4.6: FW_Tcost_{tfwg}

	Facility 1 f=1	Facility 2 f=2
Warehouse 1 w=1	0.2	0.5
Warehouse 2 w=2	0.3	0.1

Table 4.7: W_lcost_{twg}

Warehouse 1 w=1	Warehouse 2 w=2
0.07	0.05

Table 4.8: WC_Tcost_{twcg}

	Warehouse 1 w=1	Warehouse 2 w=2
Customer 1 c=1	0.6	0.3
Customer 2 c=2	0.4	0.5
Customer 3 c=2	0.3	0.4

Table 4.9: LC_{tcg}

	Customer 1 c=1	Customer 2 c=2	Customer 3 c=3
Time	Goods g = 1	Goods g = 1	Goods g = 1
t = 1	0	0	0
t = 2	0	0	0
t = 3	0	0	0
t = 4	30	20	10
t = 5	55	40	50

Table 4.10: (BOM_{gp})

Part	Goods (g = 1) Demand
p = 1	1
p = 2	2
p = 3	3

$ET_{vf} = 1$ $ET_{fw} = 1$ $ET_{wc} = 1$

Now AAA company wants to determine the following plans:

- Material purchasing plan: amount of materials pl, p2, p3, from vendors v1 and v2 at period t1, t2, t3, t4, t5
- Production plan: amount of goods produced at facilities f1 and f2 at each period
- Inventory plan: amount of materials and goods stored in vendors v1, v2, facilities f1, f2 and warehouse w1 and w2.
- Transportation plan: materials and goods transported among vendors, facilities, warehouses and customers.

All these plans are correlated to each other and SCM 1.0 can help AAA company to do these plans simultaneously. SCM 1.0 will first formulate these plans as a mathematical model. This mathematical model is coded by LINGO (Schrage 1997) depicted in the appendix.

Figure 6 and Table 5 show the final optimal solution which has been arrived at. The material purchasing plan suggested by SCM 1.0 is as follows. Take period 1 (t = 1) for instance,

R^{vf}_{t111} which means F1 purchases P1 from V1 at amount of 65,

R^{vf}_{t112} which means F1 purchases P2 from V1 at amount of 130,

R^{vf}_{t122} which means F2 purchases P2 from v1 at amount of 35.

The production plan suggested by SCM 1.0 is as follows:

R^{ff}_{t11} means F1 produces goods g1 at amount of 65 at t = 2, and

R^{ff}_{e1} means F2 produced goods g1 at amount of 35 at t = 2.

The inventory amount can be computed as follows: At t = 3, warehouse w, accepts goods from F1 at amount of 50, but w1 only transports 30 units of goods to customers at the same time. So the inventory at w1 is 50 – 30 = 20.

Table 5: The Optimal Solution

	T=1	2	3	4	5	6
R^{vf}_{t111}	65	70	5	5		
R^{vf}_{t112}	130	140	10	10		
R^{vf}_{t122}	35	35	5	5		
R^{vf}_{t121}	70	70	10	10		
R^{vf}_{t213}	195	210	15	15		
R^{vf}_{t223}	105	105	15	15		
R^{ff}_{t11}		65	70	5	5	
R^{ff}_{t21}		35	35	5	5	
LF^{g}_{t11}					5	10
LF^{g}_{t21}		↓	↓		5	10
R^{fw}_{t111}		50	70			
R^{fw}_{t121}		15				
R^{fw}_{t211}					$\sum$=100+105=205	
R^{fw}_{t221}		35	35			
R^{wc}_{t111}						
R^{wc}_{t121}						
R^{wc}_{t131}			20	40		
R^{wc}_{t221}			10	50	$\sum$=60+145=205	
R^{wc}_{t231}			30	55		
LC_{t11}				30	55	
LC_{t21}				20	40 $\sum$=60+145=205	
LC_{t31}				10	50	

A user can access SCM 1.0 through http://140.113.73 493/lab web/lab htm.

Users can access SCM 1.0 through http. 140. 113. 73 193/lab web/lab htm. Users are required to have LINGO 5.0 or 6.0 to operate this system. SCM 1.0 provides convenient tools to edit data and maps. A detailed

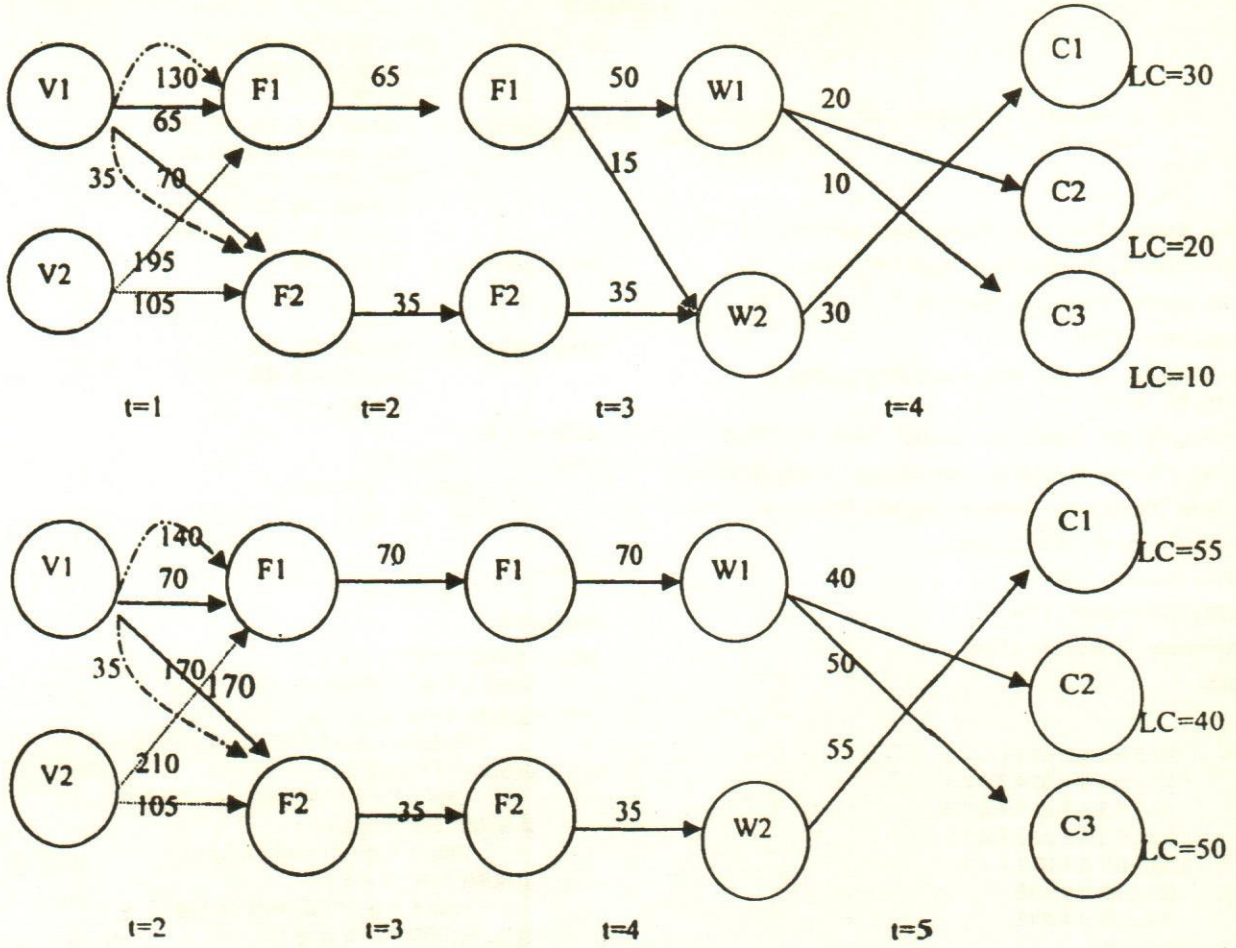

Fig. 6. The Optimal Solution

description about the design of its map and data bases can be found in Li (1999). After editing related data files and maps, users can retrieve information.

SCM 1.0 allows an authorized user to update data through the Internet. It also allows the user to choose or to specify optimization models. By running optimization process, the user can obtain the optimal solution depicted in Table 5.

Concluding Remarks

SCM 1.0 provides a user friendly GIS interface and powerful optimization models to assist the decision maker to manage a supply chain. It has been applied well in some Taiwanese electronic companies to formulate strategic plans.

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Appendix

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Model:
Sets:
Time        /1..5/; Vendor /1..2/; Facility /1..2/; Warehouse /1..2/;
              Customer /1..3/;
Part        /1..3/;
Goods       /1..1/;
TVP (Time, Vendor, Part): Ltvp, Mcost, Ltvp_UpBound;
TVFP (Time, Vendor, Facility, Part): Rtvfp, VF_Tcost;
TFP (Time, Facility, Part); Ltfp, FM_Icost;
GP (Goods, Part): BOM;
TFG (Time, Facility, Goods): Rtfg, Pcost, Rtfg_UpBound,
      Ltfg, FG_Icost;
TFWG (Time, Facility, Warehouse, Goods): Rtfwg, FW_Tcost;
TWG (Time, Warehouse, Goods): Ltwg, W_Icost, Ltwg_UpBound;
TWCG (Time, Warehouse, Customer, Goods): Rtwcg, WC_Tcost;
TCG (Time, Customer, Goods): Ltcg;
VF (Vendor, Facility): LTvf;
FW (Facility, Warehouse): LTfw;
WC (Warehouse, Customer): LTwc;
ENDSETS
DATA:
Mcost =     10.5 6.5 8.5 20.5 7.5 7.5
            10.4 6.4 8.4 20.4 7.4 7.4
            10.3 6.3 8.3 20.3 7.3 7.3
            10.2 6.2 8.2 20.2 7.2 7.2
            10.1 6.1 8.1 20.1 7.1 7.1;
Pcost =     0.4 0.45 0.4 0.45
            0.4 0.45 0.4 0.45
            0.4 0.45;
VF_Tcost =  0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01
            0.01 0.01 0.01 0.01 0.01 0.01;
FW_Tcost =  0.2 0.3 0.5 0.1
            0.2 0.3 0.5 0.1
            0.2 0.3 0.5 0.1
            0.2 0.3 0.5 0.1
            0.2 0.3 0.5 0.1;
WC_Tcost =  0.6 0.4 0.3 0.3 0.5 0.4
            0.6 0.4 0.3 0.3 0.5 0.4
            0.6 0.4 0.3 0.3 0.5 0.4
            0.6 0.4 0.3 0.3 0.5 0.4
            0.6 0.4 0.3 0.3 0.5 0.4;
FM_Icost =  0.02 0.02 0.02 0.01 0.01 0.01
            0.02 0.02 0.02 0.01 0.01 0.01
            0.02 0.02 0.02 0.01 0.01 0.01
            0.02 0.02 0.02 0.01 0.01 0.01
            0.02 0.02 0.02 0.01 0.01 0.01;
FG_Icost =  0.1 0.09 0.1 0.09
            0.1 0.09 0.1 0.09
            0.1 0.09;
W_Icost =   0.07 0.05, 0.07 0.05
            0.07 0.05 0.07 0.05
            0.07 0.05;
Ltvp_UpBound = 500 500 500 500 500 500
               500 500 500 500 500 500
               500 500 500 500 500 500
               500 500 500 500 500 500
               500 500 500 500 500 500;
Rtfg_UpBound =  70 35 70 35
                70 35 70 35
                70 35;
Ltwg_UpBound = 400 500 400 500
               400 500 400 500
               400 500;
BOM = 1 2 3;
Ltcg =      0 000 0 0
            0 0       0 30 20 10
            55  40  50;
LTvf =      1 1 1 1;
LTfw =      1 1 1 1;
LTwc =      1 1 1 1 1 1;
ENDDATA
MIN = @SUM( TVP ) ( t, v, p ) :
      Ltvp( T, v, p ) * Mcost ( t, v, p ) ) +
      @SUM( TVFP ( t, v, f, p ) :
            Rtvfp( t, v, f, p ) * VF_Tcost ( t, v, f, p ) ) +
      @SUM( TFP ( t, f, p ) :
            Ltfp( t, f, p ) * FM_Icost ( t, f, p ) ) +
      @SUM( TFG ( t, f, g ) :
            Rtfg( t, f, g ) * Pcost ( t, f,g ) ) +
      @SUM( TFG ( t, f, g ) :
            Ltfg( t, f, g ) * FG_Icost ( t, f, g ) ) +
      @SUM( TFWG ( t, f, w, g ) :
            Rtfwg( t, f, w, g ) * FW_Tcost ( t, f, w, g ) ) +
      @SUM( TWG ( t, w, g ) :
            Ltwg( t, w, g ) * W_Icost ( t, w, g ) ) +
      @SUM( TWCG ( t, w, c, g ) :
            Rtwcg( t, w, c, g ) * WC_Tcost ( t, w, c, g ) );

NP = @size (Time);
@FOR( TFG: @GIN(Rtfg) );
@FOR( TVFP: @GIN(Rtvfp) );
@FOR( TFWG: @GIN(Rtfwg) );
@FOR( TWCG: @GIN(Rtwcg) );
@FOR( TVP: @GIN(Ltvp) );
@FOR( TFP: @GIN(Ltfp) );
@FOR( TFG: @GIN(Ltfg) );
@FOR( TWG: @GIN(Ltwg) );
@FOR( TVP( t, v, p):
      Ltvp ( t, v, p) < = Ltvp_UpBound( t, v, p) );
@FOR( TFG( t, f, g) :
      Rtfg(t, f, g) < = Rtfg_UpBound( t, f, g) );
@FOR( TWG( t, w, g) :
      Ltwg( t, w, g) < = Ltwg_UpBound( t, w, g) );
@FOR( TVP( t, v, p) :
@SUM( Facility( f) :
      Rtvfp( t, v, f, p) ) = Ltvp( t, v, p) );
@FOR( TFP( t, f, p) | t #LT# NP :
      Ltfp( t, f, p) +
@SUM( Vendor( v) | t #GT# LTvf( v, f) :
      Rtvfp(t - LTvf( v, f), v, f, p) ) -
```

```
@SUM( GP( g, p) :
      BOM( g, p) * Rtfg( t, f, g) ) =
      Ltfp( t + l,f,p) );
@FOR( TFP( t, f, p) | t #EQ# 1 :
      Ltfp( t, f, p) = 0 );
@FOR( TFG( t, f, g) | t #LT# NP :
      Ltfg( t, f, g) +
      Rtfg( t, f, g) -
@SUM( Warehouse( w) :
      Rtfwg( t, f, w, g) ) =
      Ltfg( t + l, f, g) );
@FOR( TFG( t, f, g) | t #EQ# l :
      Ltfg( t, f, g) = 0 );
@FOR( TWG( t, w, g) | t #LT# NP:
      Ltwg( t, w, g) +
@SUM( Facility( f) | t #GT# LTfw( f, w) :
      Rtfwg( t - LTfw( f, w), f, w, g) ) -
@SUM( Customer( c):
      Rtwcg( t, w, c, g) ) =
      Ltwg( t + l, w, g);
@FOR( TWG( t, w, g) | t #EQ# l :
      Ltwg( t, w, g) = 0 );
@FOR( TCG( t, c, g):
@SUM( Warehouse( w) | t #GT# LTwc( w, c) :
      Rtwcg(t - l Twc( w, c), w,e,g) ) = l teg(t,c,g) ) :
END
```

□

The best executive is the one who has sense enough to pick good men to do what he wants done, and self-restraint enough to keep from meddling with them while they do it.

– Theodore Roosevelt

First learn the meaning of what you say, and then only speak.

– Epictetus

Feature

JIT/TQM Quality Techniques in Indian Industries

Vikas Kumar, Dixit Garg & N.P. Mehta

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

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

In 1990's, several success stories of Japanese and American manufacturing sector motivated Indian industries to implement JIT/TQM practices. Although many studies have indicated that implementation of JIT/TQM Quality Techniques in India is not an easy job, attempts towards these principles are being made in several Indian industries. High inventory is the main factor responsible for inferior quality; inventory is an evil because of its non value added nature (Chong and Rundus et al, 2000). Product quality can also be increased by effective implementation of 'Quality Circles'. Quality Circles identify, analyze and solve problems and present solutions to management for implementation authorization. Management commitment and direct involvement is essential for successful implementation of JIT/TQM Quality Techniques (Forza 1996). In JIT/TQM environment, the management allows workers to try and, if they fail, to learn from failures.

Quality Circles identify, analyze and solve problems and present solutions.

JIT/TQM Quality Techniques assess and appreciate quality concepts as also the existing culture, habit, norms and values of employees. Employees work best and produce quality products only when they feel valued and encouraged to contribute their own thoughts (Bonito 1990). Therefore, employee evolvement, commitment and promotion of open decision-making are requisites for JIT/TQM Quality Techniques.

In short, making quality everybody's responsibility, high level of visibility on quality control, strict product quality compliance, matching worker responsibility with authority, self correction of worker generated defects, 100 per cent quality inspection of products, routine maintenance, continual quality improvement, long term commitment to quality control efforts are some basic fundamentals of JIT/TQM Quality Techniques. Once the use of quality techniques becomes a part of manufacturing routine, continuous quality improvement and waste elimination become everyone's objective.

Past Studies

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

Work force practice in Indian context

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

Lack of understanding, insufficient mechanisms, lack of shared vision and poor commitment are key obstacles in implementation of quality improvement techniques.

JIT/TQM practices have some considerable negative implications at various levels. These are:

- JIT/TQM practices demand appropriate 'fit' between new techniques and organisational design, structure and processes. Therefore, firms cannot expect favorable results just by their implementation. Furthermore, success depends critically on executive (management) commitment, employee empowerment and an open organisational culture (Flynn 1995; Powell 1995; Selto et al, 1995).
- JIT/TQM practices require unrealistic employee commitment levels. Additionally, these practices have need of excessive re-training costs and multifunctional workers. (Sewell & Wilkinson 1992, Balakrishnan et al, 1996).
- Implementation of JIT/TQM practices does not automatically increase profit because benefits from their adoption may be offset by its many direct and indirect costs (Priestman 1985; Selto et al, 1995).
- Kanban requires longer time to transmit any new information through the manufacturing system as compared to centralized information processing system (Ackroyd et al. 1988; Powell 1995).

- Smaller lot sizes require increased efficiency and reliability of production process because multiple sourcing becomes difficult under JIT (Garg 1997, Garg & Deshmukh 1999).
- JIT/TQM practices require continuous assessment to achieve a sustained improvement in quality. They also require idealistic continuous close cooperation and communication at various levels of industries (Voss 1990).
- JIT/TQM practices also have negative implications for workers. Workers are in fact subject to highly visible forms of managerial power, control and processes of 'constant surveillance and monitoring of output & performance' (Delbridge, 1995; Sewell & Wilkinson 1992).

Success and failure studies

JIT/TQM practices are spreading throughout the world. Some reputed companies such as Lucas Electrical, South Wales; Rank Xerox, Netherland; New united Motor Manufacturing USA; Repco Clutch Company Australia, Hewlett-Packard, USA, Computervision corp. Manchester are examples of successful implementation of JIT/TQM practices. But in some companies, such practices did not help in improving quality. Florida Power and Light (FP&L) USA, for example, launched a quality improvement drive with the ambitious objective of becoming the first U.S. Company to win Japanese Deming Prize. The company gave its employees only six months to become experts on Deming method before making it 'the mandatory approach in all problem-solving situation'. To fulfill Deming method reluctant employees were forced to use the rigid analytical techniques and in November 1989, Florida Power & Light became the first American Company to capture the Japanese Deming prize. Right after that, company's business started to deteriorate and their position in the market got worse (Weisendanger, 1993). FP&L's experience with the Deming method is an instructive lesson about the dangers of blind implementation of JIT/TQM practices ignoring the impact of work culture on organisational effectiveness This incident is indicative of what can happen when Indian industries adopt Japanese or any other management techniques too enthusiastically.

JIT/TQM practices in Indian industries: A survey

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

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

Methodology

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

Table 1: General Profile of Companies

• Type of Company	Automobile: 9, Heavy machine: 12, Electronics: 7, Others: 18
• Annual Turn over (In crores)	Maximum (2200), Minimum (6), Average (306)
• Number of employee	Maximum (6750)), Minimum (27), Average (1656)
• Number of employee (In quality control department)	Maximum (212)), Minimum (3), Average (38)
• Percentage of Scrap	Maximum (7.0)), Minimum (05), Average (2.6)
• Percentage of reworks	Maximum (8.5)), Minimum (1.4), Average (2.2)
• Awareness about JIT/TQM quality techniques: Yes: 35; No: 4; No Response: 7	

Analysis

Data collected was analyzed with the help of factor analysis on scale (0-100). The results obtained are presented in Tables 2 and 3. Table 2 represents 'degree

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

Quality Techniques	Highly difficult	Difficult	Average difficult	Little difficult	Easy	No Response	Mean Score (0-100)
Management techniques							
Acceptance quality level	3	6	23	9	2	3	46.19
Affinity diagram	12	15	8	8	3	–	63.58
Arrow diagram	4	6	21	13	1	1	55.97
Automation & autonomation	21	8	11	6	–	–	73.91
Benchmarking	6	14	20	5	1	–	60.32
Cellular manufacturing	13	12	17	4	–	–	68.47
Contingency planning	8	10	15	7	2	4	53.80
Cost-benefit analysis	6	6	15	13	3	3	46.19
Customer contingency table	7	9	19	8	3	–	54.89
Deming Wheel (PDCA)	16	7	10	8	5	–	61.41
Departmental Purpose Analysis	3	6	12	16	4	5	38.04
Error proofing (poke yoke)	13	15	10	6	2	–	66.84
Flexible workforce	2	3	16	18	5	2	36.41
Gantt Chart	2	7	21	11	5	–	44.56
ISO-9000	6	14	21	5	–	–	61.41
JIT purchasing	6	21	13	6	–	–	64.67
Kanban	14	12	9	5	2	4	74.40
Kaizen	21	10	8	7	–	–	62.05
Long term contract	8	11	16	7	2	2	56.52
Potential problem Analysis	5	18	13	7	3	–	58.51
Process decision program Chart	2	7	24	8	2	3	46.19
Program Evaluation & Review	6	16	16	5	1	2	59.23
Quality Circles	7	14	16	7	2	–	64.13
Quality fun, Deployment	7	17	12	6	1	3	59.23
Relation diagram	1	3	16	18	3	5	34.23
Set up time reduction	8	23	12	3	–	–	69.56
Small lot size	9	15	15	4	1	2	62.50
Standardization	1	7	18	16	4	–	41.84
Team work	–	11	16	13	2	4	42.39
Total prod. Maintenance	8	15	17	6	–	–	63.58
W.I.P. reduction	6	18	14	5	1	2	60.32
Work centered quality control	5	21	11	8	–	1	61.41
Zero defects	18	13	10	2	2	1	72.28
Analytical techniques							
Cause & Effect diagram	6	7	20	9	2	2	51.8
Critical Path Analysis	5	8	13	17	1	2	47.28
Failure Model & Effect analysis	7	20	11	8	–	–	64.13
Fault tree diagram	7	15	13	6	4	1	57.06
Force field analysis	15	13	9	6	1	2	66.84
Reliability	14	17	7	4	4	–	67.93
Robust design	8	11	18	6	3	–	58.15
Taguchi Methods	17	12	13	4	–	–	72.82
Tolerance design	3	9	16	12	2	4	45.1
Idea generation techniques							
Brainstorming	0	8	16	12	7	3	36.97
Brain writing	2	13	13	11	4	3	45.63
Imagine ring	4	10	18	8	2	4	52.17
List Reduction	4	16	12	8	6	–	48.91
Mind mapping	3	11	17	10	2	3	48.36
Multi voting	0	4	11	18	8	5	28.26

(Contd.)

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

Quality Techniques	Highly difficult	Difficult	Average difficult	Little difficult	Easy	No Response	Mean Score (0-100)
Data collection techniques							
Bar Charts	–	6	11	17	9	3	30.97
Box & Whisker plots	2	6	18	18	–	2	43.47
C charts	1	4	15	22	4	–	36.95
Check sheets	–	1	8	19	15	3	20.65
Cusum chart	6	4	17	13	6	–	45.10
Process Analysis	2	9	13	18	4	–	42.93
Flow charts	–	–	6	28	10	2	21.73
Histograms	–	3	5	24	9	5	23.36
Quality Policy Deployment	3	15	18	8	2	–	54.89
Matrix Diagram	5	11	16	12	–	2	52.71
Matrix Data Analysis	4	11	21	7	3	–	53.26
Multi-vari chart	8	12	12	9	5	–	54.89
Dot plots	4	4	12	15	8	3	36.41
Process capability	2	6	23	12	3	–	45.65
Sampling	3	9	11	18	5	–	42.93
Scatter Diagram	–	2	6	26	12	–	23.91
Statistical process control	7	5	12	13	9	–	43.47
Tree diagram	6	4	17	14	5	–	45.65
U-chart	–	7	21	13	2	3	40.21
X-moving range Chart	–	3	17	21	5	–	34.23
Tally charts	–	5	9	22	9	1	29.89

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

Quality Techniques	Very Good	Good	Fair	Little	Not at all	No response	Mean Score (0-100)
Management techniques							
Acceptance quality level	29	13	4	–	–	–	88.58
Affinity diagram	8	12	13	10	1	2	56.52
Arrow diagram	13	11	11	7	1	3	61.95
Automation & autonomation	11	14	12	7	1	1	63.68
Benchmarking	26	11	8	1	–	–	83.69
Cellular manufacturing	14	9	12	6	2	3	61.41
Contingency planning	9	11	16	3	3	4	56.52
Cost-benefit analysis	20	14	8	4	–	–	77.17
Customer contingency table	12	8	14	9	2	1	59.23
Deming Wheel (PDCA)	13	17	12	2	–	2	70.10
Departmental Purpose Analysis	4	5	16	13	4	4	41.30
Error proofing (poke yoke)	11	8	15	10	2	–	58.69
Flexible workforce	16	16	7	4	1	2	70.65
Gantt Chart	8	13	18	5	–	2	60.86
ISO-9000	28	12	6	–	–	–	86.95
JIT purchasing	13	15	10	6	–	2	66.84
Kanban	22	16	6	1	–	1	80.97
Kaizen	6	8	17	10	2	3	50.00
Long term contract	11	12	16	4	2	1	63.04
Potential problem Analysis	22	12	9	3	–	–	78.08
Process decision program Chart	3	5	18	13	3	4	41.30
Prog. Evaluation & Review	6	17	13	7	1	2	58.69

(Contd.)

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

Quality Techniques	Very Good	Good	Fair	Little	Not at all	No response	Mean Score (0-100)
Quality fun, Deployment		14	16	7	8	1	–
Relation diagram	2	9	17	12	2	4	44.02
Set up time reduction	24	15	7	–	–	–	84.23
Small lot size	8	13	18	5	2	–	60.86
Standardization	27	16	3	–	–	–	88.04
Team work	25	15	6	–	–	–	85.32
Total prod. Maintenance	16	21	7	2	–	–	77.71
W.I.P. reduction	16	18	8	2	–	2	73.91
Work centered quality control	15	12	17	2	–	–	71.39
Zero defects	25	17	4	–	–	–	86.41
Analytical techniques							
Cause & Effect diagram	16	22	4	4	–	–	77.17
Critical Path Analysis	9	13	18	17	6	–	–
Failure Model & Effect analysis	17	18	6	3	–	2	74.45
Force field analysis	2	10	8	15	8	3	37.50
Reliability	18	21	6	1	–	–	80.43
Robust design	5	7	17	11	2	4	46.73
Taguchi Methods	5	5	12	17	2	5	41.30
Tolerance design	19	22	4	1	–	–	82.06
Idea generation techniques							
Brainstorming	28	12	5	1	–	–	86.41
Brain writing	14	16	9	3	2	2	67.93
Imagine ring	8	6	8	13	7	4	42.93
List Reduction	15	13	10	5	2	1	67.39
Mind mapping	5	3	7	16	6	9	32.06
Multi voting	6	6	12	14	3	5	43.47
Data collection techniques							
Bar Charts	20	19	4	3	–	–	80.43
Box & Whisker plots	6	3	11	19	3	4	40.21
C charts	8	6	7	9	7	9	39.67
Check sheets	21	13	5	6	–	1	86.41
Cusum chart	–	–	16	17	5	8	26.63
Process Analysis	–	6	18	13	7	2	36.41
Flow charts	14	19	11	2	–	–	74.45
Histograms	17	22	7	–	–	–	80.43
Quality Policy Deployment	16	19	8	3	–	–	76.08
Matrix Diagram	12	8	14	8	2	2	58.69
Matrix Data Analysis	5	11	16	9	5	–	51.08
Multi-vari chart	3	3	11	17	7	5	32.6
Dot plots	2	9	13	18	3	1	42.93
Process capability	2	6	23	12	3	–	45.65
Sampling	3	9	11	18	5	–	42.93
Scatter Diagram	–	2	6	26	9	3	23.91
Statistical process control	7	5	12	13	6	3	43.47
Tree diagram	6	4	17	14	4	1	45.65
U-chart	–	7	21	13	5	–	40.21
X-moving range Chart	–	3	17	21	4	1	34.23
Tally charts	–	5	9	22	8	2	29.89

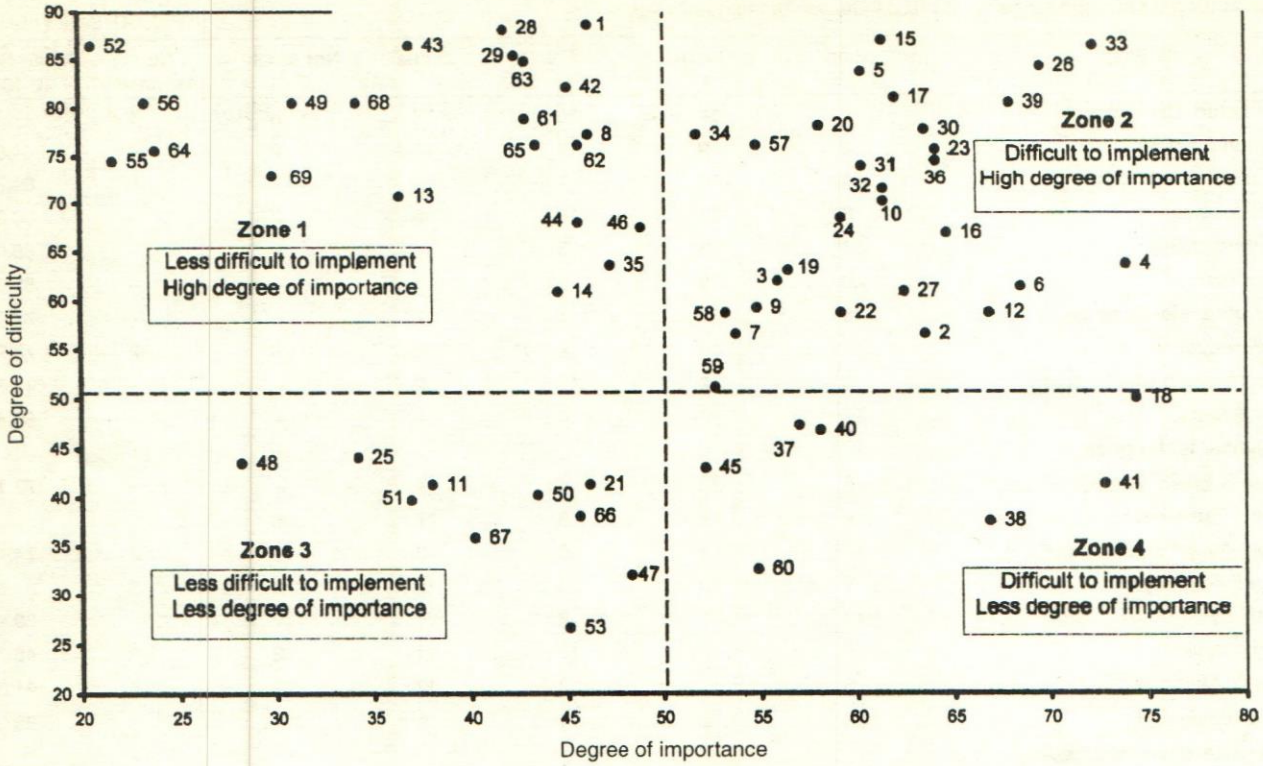

Fig. 1. Present Status of JIT/TOM practices in Indian industries

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

of difficulty' in implementation of quality techniques as perceived by respondents and Table 3 indicates the state of importance being given by surveyed companies to quality techniques of JIT/TQM practices. The mean scores of Tables 2 and 3 were put in XY scatter chart, which indicates present status of quality techniques in Indian context (Fig. 1). X-axis and Y-axis of XY scatter chart represent 'degree of difficulty in implementation' and 'degree of importance' respectively. The plot area of XY scatter chart is divided into four zones. The quality techniques like acceptance quality level, flexible workforce, gantt chart, standardization, team work, critical path analysis, tolerance design, brainstorming, brain writing, list reduction, bar charts, check sheets, flow charts, histograms, dot plots, process capability, sampling, scatter chart, static process control, X-moving range (X-MR) and chart tally chart fall in zone 1, which point towards their great importance in Indian industries. In addition, Charts also indicate that fewer efforts are required to implement these techniques. On the contrary, quality techniques under zone 4 (kanban, fault tree diagram, force field analysis, robust design, taguchi methods, imagineering, multi-vari chart) have been given less attention as compared to others. Zone 2 of chart indicates that number of quality techniques like affinity diagram, arrow diagram, automation & autonomation, benchmarking, cellular manufacturing, contingency planning, cost-benefit analysis, customer contingency table, Deming wheel (PDCA), error proofing (pokeyoke), ISO-9000, JIT purchasing, kaizen, long term contract, potential problem analysis, programme evaluation & review, quality function deployment, set up time reduction, small lot size, total productive maintenance, W.I.P. reduction, work centered quality control, zero defects, cause & effect diagram, failure mode & effect analysis, reliability, quality policy deployment, matrix data analysis and matrix diagram have great importance in Indian context but these techniques require sincere efforts for implementa-

tion. The quality techniques under zone 3 (departmental purpose analysis, process decision program chart, relation diagram, mind mapping, multi voting, box & whisker plots, C charts, cusum chart, tree diagram,) are easy to implement but surveyed companies have accorded these techniques less priority.

Conclusions

The survey conducted in this study reveals the importance of JIT/TQM Quality Techniques in Indian context. But, Indian industries need cautious planning and full teamwork for implementation of such techniques. Furthermore, techniques such as quality circle, total preventive maintenance, cause and effect diagram, quality policy deployment, affinity diagram, kaizen, benchmarking, JIT purchasing, matrix diagram require more attention since their implementation may be helpful to improve present position of Indian industries in areas of quality, cost and flexibility by developing specific time bound quality improvement action plans. Following issues need further scrutiny:

- Managers and employees think and behave differently in different countries; therefore a cross-nation comparison can be made that would be helpful to highlight the performance of different quality improvement techniques in different regions.
- Some standard performance measures must be identified so that impact of different quality techniques can be easily measured on organisational performance.
- Now-a-days, application of Supply Chain Management (SCM) is continuously growing in practice. It is therefore essential to study the impact of Supply Chain Management (SCM) on product quality.

Information Technology (IT) has tremendous impact on quality control communication. Some successful manufacturing companies are using Infor- mation Technology to control product quality efficiently and also to increase their customer reach. Information technology changes the ways of conducting businesses. Internet, EDI, Electronic funds transfer, e-mail have made several traditional systems obsolete. Indian industries must implement these new technologies to speed up design and retrieval process through effective use of R & D. In general, JIT/TQM Quality Techniques have generated awareness about quality and associated cost at every level, and in every sector of Indian industries. But, their effectiveness would depend upon Indian workforce situation, people's socialization behaviour pattern, personality traits, attitudes and values.

Effectiveness would depend upon Indian workforce situation, people's behaviour pattern, attitudes and values.

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What is critical to the customer's success? Learning the answer to that question and then learning how to provide the solution is the only focus we need.

– Jack Welch

Feature

TQM & National Culture: A Contingency Model

Naceur Jabnoun & Syed Aziz Anwar

In view of globalization of business, TQM implementation across cultures is the subject of active research agenda.. While formal barriers to international trade and investment flows have been substantially reduced over the last four decades, business practices of firms continue to be cultural context-specific, to a great extent. This trend has important implications for the question of how far TQM implementation will go. If the depth and width of globalization is limited by the reach of cultural boundaries, does it not logically follow that national cultures impose constraints on TQM implementation? Can TQM become universal while culture remains local? Or, to ask a different but related question, what would TQM implementation look like in a world characterised by globalization on the one hand and the existence of different cultural contexts on the other? This paper seeks to provide a contingency model of TQM implementation across cultures.

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In the emerging scenario of globalization of business, it is argued with passion and emphasis that Total Quality Management (TQM) can be used universally for improving quality and productivity (Crosby, 1979; Deming, 1986; Juran, 1989). However, this argument has been challenged by a school of thought in recent years. Spencer, (1994); Chorn, (1991), Laza & Wheaton (1990) and Ngowi (2000), for instance, have highlighted that each organisation is conditioned by the national environment and TQM's successful implementation, therefore, cannot be automatically guaranteed universally. National cultural differences can be identified on the basis of how their members perceive the world (Stewart & Bennett, 1991) how information is processed, conceptions of time (Hall & Hall, 1990), how individuals associate themselves with each other, the dynamics of human activity, and the human nature (Trompenaars, 1994) The oft-quoted cultural variations (Glenn & Glenn, 1981; Kluckhorn & Strodbeck, 1961; Triadis & Albert, 1987; Hofstede, 1980, 1991) and their logical implications for TQM implementation are analytically interesting. Tata and Prasad (1998) suggest that countries with low power distance and uncertainty avoidance are likely to be more successful in implementing TQM. This suggestion may, however, be challenged on the assumption that TQM requires an organic structure and a flexibility-oriented culture.

Each organisation is conditioned by the national environment and TQM's successful implementation, cannot be automatically guaranteed universally.

While the need to address the impact of national cultures on TQM implementation has been emphasized, the difficulty of stylizing or modeling the cultural values and the implicit assumptions about them for the pur-

pose of effectively implementing TQM has often been overlooked (Ngowi, 2000; Carbett & Rastrick, 2000).

Although, many constructs of culture are available in contemporary literature, we shall use the Hofstede model for the purpose of this paper because of its suitability to TQM implementation. Our objective in this paper is to strengthen the literature by developing a contingency model of TQM implementation in interaction with national culture. A research exercise of this kind, we believe, would help facilitate the process of TQM implementation.

Reflections on National Culture

A formidable body of research has been built up in recent years focusing on the definition and variations in national cultures (Glenn & Glenn, 1981; Kluckhorn & Strodbeck, 1961; Triadis & Albert, 1987; Hofstede, 1980, 1991) and the impact of national cultures on TQM. A literature review suggests that culture may be defined in view of its intended use as a determining criteria. Functionalists measure culture as something the organisation "has". They are thus prone to examine organisational culture. Anthropologists, sociologists and social psychologists, however, consider culture as being the basis of the organisation's existence. It is, therefore, something the organisation "is" (Moenaert, 1994). The distinction between national and organisational culture is important as the two are composed of different elements (Hofstede 1980, 1991). Organisational culture is the shared perception of daily practices. National culture is the shared values of people within a certain national environment. Values are learned from the socialization process in which the individual participates as a member of society, while organisational cultural practices are acquired from socialization in the workplace.

Organisational culture is the shared perception of daily practices. National culture is the shared values of people within a certain national environment.

National culture for the purposes of this study will be defined as "the collective programming of mind which distinguishes one national group or category of people from another, (*thus*) the interactive aggregate of common characteristics that influences a human group's response to its environment" (Hofstede, 1980). Culture is not directly observable, but is inferrable from observed behaviors and statements. National culture implies that shared values distinguish the behavioral patterns of one group from another. Interestingly, national culture is bound to influence organisational culture, thus having great implication for productivity.

Hofstede's Dimensions of National Culture

Hofstede (1980, 1991) suggests that cultural differences between nations can be described using bipolar dimensions. The position of a country on these dimensions paves the way for predictions about how each society and its management processes operate. Hofstede's dimensions of national culture are as follows.

Power Distance

Power Distance (PD) is the degree of inequality among people running from relatively equal to extremely unequal. It explains the degree to which members of a culture are prepared to accept and expect inequality between superiors and subordinates. Logically, more PD societies display very hierarchical systems. In high PD cultural contexts, it is typical that superior- subordinate relations are characterized by total obedience on the part of subordinates for superiors. In low PD cultures, on the other hand, superiors tend to be democratic and adopt consultative processes to take decisions. In higher PD cultures, subordinates expect and accept close supervision of their work and performance. They lack creativity and tend to refer to their superiors before taking direct actions in ambiguous situations (Hofstede, 1980). In low PD cultures, subordinates tend to question their superiors and are quite often willing to give constructive suggestions.

Individualism-Collectivism

Individualism-Collectivism is the degree to which people act as individuals or as group members. Consequently, rewards for achievement of goals differ according to the degree of Individualism and collectivism of a nation. Individualistic societies, for instance, would reward the individual and non-conformist more than collectivist societies. Achievement-oriented societies such as American and Swedish place great emphasis on skill and knowledge of individuals and they are rewarded accordingly. Individuals in these societies feel unconstrained by environmental factors and can exercise self-improvement. Societies such as Japanese and Chinese that place high emphasis on group work tend to motivate organisational members with the help of government-driven group incentive schemes.

Masculinity-Feminity

Masculinity-Feminity is the degree to which Mas-

culine values such as assertiveness, performance, success and competition prevail. In Western societies, individuals tend to be more assertive and goal-oriented and aid in the process of attaining a higher degree of performance. They take pride in their work and expect recognition of their Masculine values. In Masculinity–driven societies, management styles logically are assertive to provide a clear sense of direction to organisational members to attain goals and objectives.

Uncertainty Avoidance

Uncertainty Avoidance is the degree to which people in a society prefer structured over unstructured situations. Societies that prefer to have High Uncertainty Avoidance are likely to have well-planned organisation structures. Societies that are found to have Uncertainty Avoidance will seek to exercise control through well-planned processes. These societies are likely to encourage formal organisation structures for decision making and are unlikely to promote informal organisation structures.

Long-term-Short-term Orientation

Long-term-Short-term Orientation considers Long-term values such as thrift, savings and persistence. A society with these values would rely on organisation structures influenced by a strategic mode of thinking. Organisations that rely on Long-term Orientation demonstrate a pattern of major goals and objectives, and a clear road map to attain these goals and objectives over a period of time. They tend to conduct their business against the backdrop of a vision and mission and interact with their environment on a continuous basis. Organisations with Short-term Orientation, on the other hand, tend to be tactical in their responses to the environment and demonstrate a noticeable degree of ad hocism in their decision making.

National cultures as defined and articulated by Hofstede (1980, 1991) affect organisations through the role they play in determining corporate structures and cultures (Egan, 1994). It is, necessary, to understand the nature of a TQM organisation in order to analyze how it is affected by national culture. Clemmer (1992) described the TQM–oriented organisation as the one that is totally opposite of the mechanistic organisation. Price (1989) considered TQM as an alternative to "Management by Control". On the other hand, the quality assurance segment of TQM and its emphasis on reducing variations and getting processes to be in control (Spencer, 1994) can lead to a conclusion that TQM is a repackaging of Taylorism and the mechanistic organisation (Dean & Bowen, 1994). These kinds of diverse and at times contradictory explanations in the literature may be attributed to an inherent duality in the goals of TQM. Curiously enough, more control is needed to reduce variations and achieve conformance, but arguably, at the same time, workers' empowerment and learning are needed to pursue customer satisfaction (Sitkin, Sutcliffe, & Shroeder, 1994). Tamuz (1987) suggested that the incompatibility between pursuit of learning and pursuit of control calls for achievement of a critical balance that matches the situation and priority of the organisation.

The incompatibility between pursuit of learning and pursuit of control calls for achievement of a critical balance that matches the situation and priority of the organisation.

The influence of both the national and organisational cultures on TQM implementation was empirically studied by Ngowi (2000) in the construction sector in Bostwana. The study found that TQM may or may not be consistent with the organisational and/or national culture. Furthermore, the study highlighted that the commitment of management towards TQM is not only essential but should also be communicated to every participant in the organisation. In fact, the invaluable role of senior management in shaping the organisation as a well-knit team of personnel committed to attain the avowed objectives of quality has been emphasised with unanimity in literature (Corbett & Rastrick, 2000). These values can of course be operationalized in product and productivity-related contexts (Nakata & Sivakumar, 1996).

TQM Implementation

In order to facilitate our task of ironing out incompatibility between TQM goals, we shall separate the control and learning segments of TQM. To be able to do that, let us first define quality control, quality assurance, and total quality management. Quality control is concerned primarily with control through inspection and statistical tools. The purpose of quality control is conformity (Gravin, 1988; Dale *et al*, 1990). Quality assurance stems from quality control. It is concerned with quality planning and defect prevention through programs and documented systems (Gravin, 1988). The purpose of quality assurance is also conformity (Dale *et al*, 1990). Total Quality Management is a comprehensive management approach aiming at satisfying or delighting the customer. It is concerned about the quality assurance dimension of standardization of quality but extends beyond it to include continuous improvement

(Anderson *et al,* 1994) and total customer satisfaction where customers are both internal and external to the organisation (Juran, 1979). The tools of TQM are not restricted to systems and statistical tools but include establishment of a quality vision and infusion of a quality culture based on cooperation, commitment to quality, and learning.

Tools of TQM are not restricted to systems and statistical tools but include establishment of a quality vision and infusion of a quality culture based on cooperation, commitment to quality, and learning.

TQM implementation requires that the four components of quality control, quality assurance, continuous improvement, and total customer satisfaction be implemented systematically. Quality control and quality assurance represent the control dimension while continuous improvement and total customer satisfaction represent the learning dimension. Quality control is achieved through supervision, inspection and control. Quality assurance is achieved through the development of a quality system while continuous improvement is achieved through programs as well as a vision and culture of commitment to quality and learning. Total customer satisfaction includes the satisfaction of both internal customers through empowerment, team work, and cooperation as well as the satisfaction of external customers through commitment, cooperation and responsiveness. This particular dimension, in fact, represents the advances made in marketing theory. We now turn to present a contingency model for effectively implementing a TQM program that hopefully would bridge a gap in existing literature.

A Contingency Model

This model is based on the four components of TQM implementation, namely quality control, quality assurance, continuous improvement and total customer satisfaction. The model is presented in Fig. 1. Let us now explain the components of TQM implementation as follows.

Quality Control

This component deals with supervision, inspection and control. It can be implemented effectively in countries with high power distance such as Singapore, Honk Kong, Phillipines, Mexico and Venezuela (Hofstede, 1980, 1991). The study of Adam *et al,* (1998) appears to support this suggestion. While recognizing that New Zealand which has a low power distance was found to be also more into quality control mode than total customer satisfaction, it was found that more high power distance countries such as Honk Kong, Mexico and China had more inspection driven quality management.

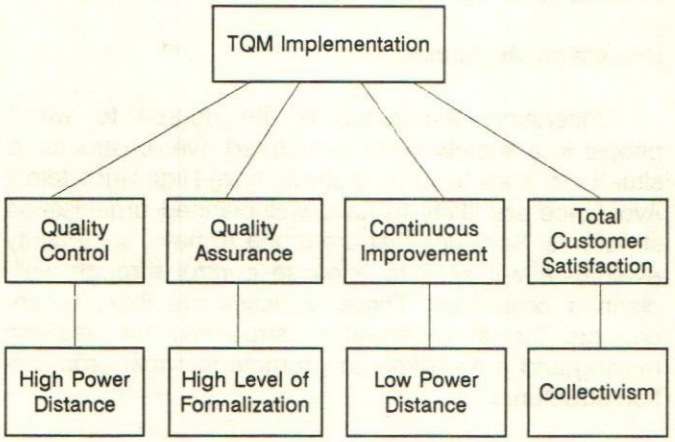

Fig. 1. A Contingency Model for TQM Implementation based on National Culture

Quality Assurance

This component focuses on planning for quality through documented systems. This implies that quality assurance requires a high level of formalization. Logically, we can suggest that countries with high uncertainty avoidance are well-placed to implement quality assurance. A large majority of organisations in Europe, where low uncertainty avoidance is dominant, are working for or have quality systems (Hofstede, 1991)

Continuous Improvement

Continuous improvement requires a culture of commitment to quality and learning. This in turn represents a low level of uncertainty avoidance and a low level of power distance. Countries like US, UK, Sweden and Denmark are quite suited for the implementation of this component. US companies have generally been successful in their continuous improvement efforts (George & Weimerskirch, 1994; Van Horn 1997). Furthermore, there was more evidence of continuous improvement in Swedish firms than in the export-oriented Japanese organisations.

Total Customer Satisfaction (TCS)

This component requires teamwork and empowerment of internal customers to enable them to be respon-

sive to external customers. This requires a culture of low uncertainty avoidance, low power distance, and collectivism. Organisations with a combination of these three dimensions are more suited for the implementation of this component. Absence of one or two of these dimensions could hinder the success of total customer satisfaction. Low power distance and uncertainty avoidance coupled with lack of collectivism in American culture could be the reason behind the success of American companies in continuous improvement and their relative failure in teamwork (Lawler, 1994). Evidence suggests that empowerment failed in Motorola Malaysia largely because of the culture of high power distance (Jabnoun, 1999).

Empowerment failed in Motorola Malaysia largely because of the culture of high power distance.

A total success of TQM implementation is only possible when all its components are implemented effectively. However, no single national culture is conducive for such a success. Joint ventures bringing about all the complementary cultural ingredients in a world in which markets for goods, services and factors of production are getting integrated may be the best avenue for TQM success. Establishing joint ventures between Japanese and American companies, for example, would fit well into the framework of our model. Indeed, joint ventures such as Aisin-Warner Ltd., Fuji Xerox Co. Ltd and Yokogawa-Hewlett-Packard Ltd. turned out to be quite successful and won the Deming Prize (Kondo, 1990).

No single national culture is conducive for total success of TQM implementation.

A stylized contingency model suggested in this paper provides guidelines for TQM implementation in various parts of the world, which are witnessing globalization of business. However, it may not be used as the ultimate prescription without considering other pertinent factors. Such factors include size of the firm and the technology available (Moreno-Lozon & Peris 1998). Knowledge of TQM is another important factor that helps in the implementation process. Lewis (1992) found no difference between American and Spanish Quality managers and he attributed this to their common lack of knowledge about TQM. Furthermore, corporate cultures and structures, through which national culture affects TQM implementation, are also dependent on other factors such as the type of industry and the product market strategy (Kono, 1994; Chandler, 1962) Nevertheless, our model can help practising managers interested in effectively implementing a TQM program anywhere in the world.

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As I reflect back on all the breakthroughs I've seen, one thing was always present—unbelievable clarity.

— Mike O' Brien

Feature

Total Quality Education: A Model for India

V. Mariappan

In the wake of the increasing quality consciousness around the world, industry is geared up to meet high quality standards set by the market. The education sector that produces the human resources has a pivotal role in this quality movement. That demands total quality approach in the education system to live up to the requirements of the industry and society. The present education system in India requires a sea change to cope with the changing environment. This article discusses a model for total quality education in the Indian context.

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Education has a vital role in nation building as the education sector has the prime responsibility of producing the basic input for development of human resources. Quality education is the best way to develop a rich human resource. Due to reforms in the economic policy of India, the economy and society have experienced significant changes in the past decade. These changes demand high quality and specialized education to cater to the varying needs of business and society. Now the onus vests with the education sector to respond suitably to the demand as the traditional system that was in place so far looks out of place in the current context where the market demands high performing result-oriented human resources and is willing to pay any amount for appropriate knowledge and skill.

Recent Changes in Indian Education Sector

The changes in the business environment demand transformation in the education policy of the state. The government and the educational institutions together have a role in accomplishing this task. Though some changes are taking place in the Indian education policy and system in the recent years, they are cosmetic and tentative in nature. The policy needs a complete new look and the system requires a drastic surgery to be effective and useful to the citizens, industry and the nation.

Though, some changes are positive and encouraging, there is a great cause for concern and worry regarding certain recent developments in the system. The private participation and their underlying objectives, increasing inflow of political personalities in the higher and professional education business, increasing number of self-financing courses in the Universities and affiliated institutions and the state of infrastructure facilities, the growing competition among universities in the open education and distant education programmes and the dilution in quality with the effort to get more participants, mushrooming ill equipped private educational institutions and the

menace of capitation fees are threatening the basic fibre of quality in education.

The dilution in quality with the effort to get more participants, mushrooming ill equipped private educational institutions and the menace of capitation fees are threatening the basic fibre of quality in education.

Further the growing bureaucratic control and corruption also challenges the system. Bureaucratic structures are characterized by highly established work routines, high rule structure and low task variety which increase dependency, encourage rigidity, limit autonomy, and reduce risk taking and innovative behavior decreasing employees' faith in their competency to handle tasks and situations. Bureaucracy fosters segments, creates inequalities in distribution of organisational power (Kanter 1983 & Block 1987). There is urgent need to curb bureaucracy in the education system.

Need for Total Quality Education

As knowledge economy is emerging as an important sector, there is enormous scope for India to take advantage of the opportunities to cash its rich human resource. There is lot of potential for export of the country's knowledge and enhance foreign exchange revenues. Traditionally, India has been a major exporter of human resources worldwide. Already, India has proved its supremacy in Information Technology and also to a significant extent in medical, engineering and management areas. However, competition is increasing in recent years with more countries joining in this market, particularly the South Asian countries. The importers are also looking for alternative low cost human resources. Hence Indian export of human resources, the intellectual product, is not going to be easy in the coming days. In this context, Total Quality Education for India gains importance more than ever before. The effort needs to be taken from the bottom primary level to higher technical education. Furthermore, there is cause for worry given the growing problem of unemployment and under employment. It leads to a variety of socio-economic problems and hampers individual development and national development. A poor and objectless education may turn counterproductive at times. To bail out the citizens from this evil and build a strong and prosperous India, it is high time policy makers and implementers planned towards total quality education.

Historically, management believed that increased quality is increased cost. But quality pioneers counter this view and opine that the benefits outweigh costs because of economics of quality (Juran, 1951). Feigebaum (1961) argues that Quality is everyone's job, thus expending the notion of quality cost beyond the manufacturing function. The most popular and widely accept view now is "quality is free" introduced by Philip Crosby in 1979. Costs include not only those that are direct, but also those resulting from lost customers, lost market share, and the many hidden costs and foregone opportunities not identified by modern cost accounting systems. Hence quality is mandatory, not optional.

There are two approaches to education, the traditional and the modern quality approaches. Table 1 presents the features that distinguish the two approaches.

Table 1: Two Approaches to Education: Conventional Vs. Quality Management

Conventional System	Quality Management System
Conformance to specifications	Client satisfaction and success
Control learner	Self-control
System defines quality	Client define quality
Learner is passive	Learner is active
Frequent inspection	Continuous Improvement
Cost driven	Result driven
Budget driven plan	Plan driven budgets
If it works don't change	If it works change
Quality is after the effect	Quality is continuous
Change is expensive	Change is profitable
Education costs	Education pays

Source: Kaufman Roger & Zahn Douglas; "Quality Management Plus", Crowin Press, 1993, p. 16.

Providing quality education demands understanding of the dynamics of public education system in India. The dynamics revolves around seven key features.

- Change in behaviour of consumers (Students)
- Change in behaviour of suppliers (Institutions)
- Change in competitive strategies of Institutions
- Entry of new suppliers into the sector
- Change in the policy of the Government
- Change in the use of technology and methodology

- Change in the key demographic set-up.

Figure 1 exhibits the dynamics of education system in India.

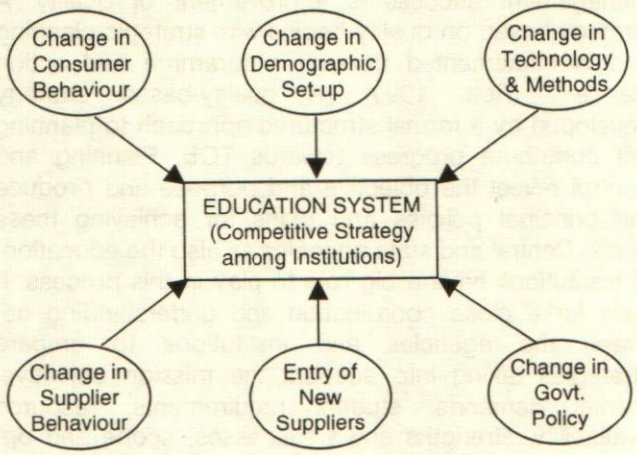

Fig. 1. Dynamics of Education System In India

Strategies Towards Total Quality Education

TQM is a business philosophy that seeks to instill in all personnel of an enterprise a collective responsibility for maintaining impeccable quality standard. It preaches that the "... entity's ability to generate and sustain quality advantages stems from the totality of its internal operations" (Ghosh, 1994). TQE is not a magical outcome and cannot be achieved through tentative and cosmetic changes in the education policy and system. It is also not a one-time job that one can achieve with a time-bound plan. On the contrary, it demands a great deal of sustained effort and unconditional commitment by every participant in the system. It should enjoy the support of human and non-human resources in the organisation and the other internal and external agencies. Education policy makers and implementers in government, the leadership and management of educational institutions, the teachers, students and parents have a significant role to play in this task. It requires a coordinated effort from various people and institutions. Figure 2 provides the total quality education model for India.

Management and Leadership

The leadership and management in education system have a key role in providing quality culture education. Leaders are the most visible and influential people in an organisation. Charismatic and transformational leaders appeal to the emotions of their subordinates and followers. Emotional state is a source of efficacy information for employees and students

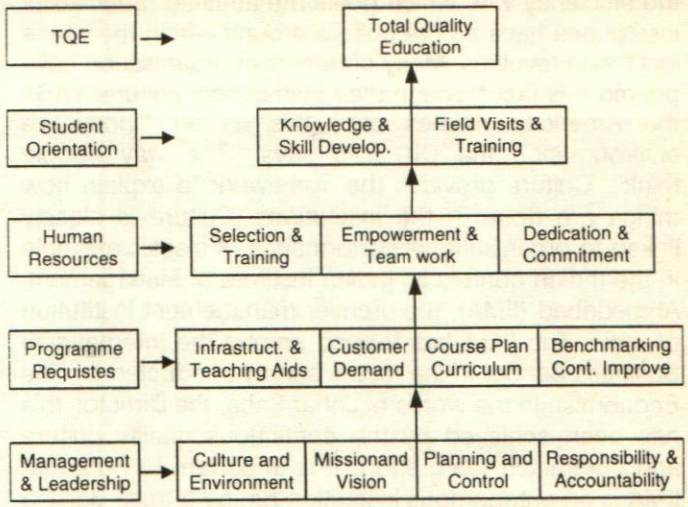

Fig. 2. Total Quality Education Model

and their self-expectancy expectations also depend on the leaders' efficiency expectations. In his assessment of the prospects for educational change, Fullan (1992) argues that while leadership relates to mission, direction, inspiration, the management involves designing and carrying out plans, getting things done, working effectively with people. Recent treatments of cultural leadership in schools have continued to focus on principals and examined the relationship between leadership, school culture and productivity. Visionary leadership, process management, individual and organisational learning, internal and external cooperation, employee empowerment and fulfillment are distinctive features of TQM. In order to obtain the right kind of leadership and quality management, the following issues are to be addressed.

Culture and Environment

An institution's survival and prosperity depends on its ability to effectively interact with its environment and achieve external adaptation. Culture helps the institution for external adaptation and internal integration. Culture is the pattern of shared beliefs and values that provide the members of an institution accepted rules of behaviour of doing the activities. It is the philosophies, ideologies, values, assumptions, beliefs, expectations, attitudes and norms that knit an organization together and are shared by all (Fred Newton, 1990). The environment is the climate set by the organisation to provide the required support for nurturing and developing the culture. Quality becomes a way of life throughout the organisation. Smircich (1983) treats culture as "something an organisation has" (p. 347) and thus emphasises how culture can be manipulated to enhance

the efficiency with which goals are attained. Successful institutions have a core culture around which the whole institution revolves. Many commercial organisation have proved this fact through their institutional culture. While the American Airlines calls this as an "innovative environment", the Du Pont says "The way people think". Culture provides the framework to explain how things are done in the institutions. Culture is closely linked to organisational performance. A classic example in the Indian context is, Indian Institute of Management, Ahmedabad (IIMA), the premier management institution of India. The IIMA has topped among the International Business School in the recent survey conducted by The Economist. In the words of Jahar Saha, the Director, this has been achieved by the continuous quality culture and committed team effort. It is important to note that IIMA is an autonomous institution run by a trust. Barring a few institutions in India today, many are crippled with economic culture rather than quality culture. Figure 3 illustrates how to transmit quality culture in education.

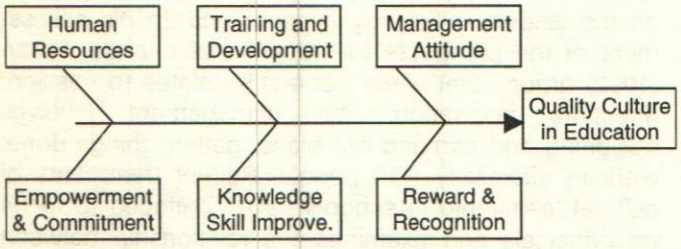

Fig. 3. Transmission to Quality Culture

Mission and Vision

TQM is a continuous iterative process of meeting the goal, where the search is for better effectiveness (Y.K. Sehgal, 1995). Mission is primarily the overall purpose of an institution and its expressed reason for its existence. Every institution must set a mission statement that states the direction the institution intends to move. It is a philosophy that may be quality education; making of top quality managers/scientists or vibrant young citizens. The objective of the institution can be achieved only through a mission with vision. Vision is the ability to see the future in the most realistic manner. It is important the mission is operationalised, failing which it will remain only a decorative word and not produce any quality result. Unfortunately, in many institutions, the mission statement is hijacked by economic, political and personal considerations leading to failure in achieving the purpose or objective of the Institution. The education system is witnessing these failures due to lack of vision and mission among the implementing agencies and the institution leadership. So in the pursuit of TQE, what is required is not just a mission statement but also its strict conscious adherence.

Planning and Control

The American Marketing Association's survey of over 3000 international managers reveals that the key to management success is improvement of quality. A strategy based on quality begins with strategic planning and is implemented through programme and action planning (Rolt, 1990). A quality-based strategy developed by a formal structured approach to planning will contribute progress towards TQE. Planning and control reveal the objective and purpose and produce the principal policies and plans for achieving these goals. Central and state agencies as also the educational institutions have a big role to play in this process. It calls for a close coordination and understanding between the agencies and institutions to prepare strategies taking into account the mission objective, market demands, student requirements, resource availability, strengths and weaknesses, scope and opportunities and social needs. This has to be a regular exercise to accommodate the emerging changes in the internal and external environment. Unfortunately, the practice and priorities are different today. Most educational institutions have the unstated primary motive of maximum revenue or profit. A shift from planning for profit to planning for quality is imperative to achieve TQE. Only those institutions that can operationalise this shift can aspire for TQE in the real sense, otherwise it will remain only in paper.

A shift from planning for profit to planning for quality is imperative to achieve TQE.

Responsibility and Accountability

In complex organisations, emphasis is on rules and routines rather than on responsibilities and accountability. Every position in formal organisations should have a clear set of responsibilities to enable management to provide guidance and direction, and ensure accountability for performance. Lack of role clarity confuses employees on their task responsibilities. Role ambiguity is created when the employee is unsure of others expectations. Low or little knowledge of an individual's authority and responsibility induces uncertainty in outcomes and creates no opportunity for employees to experiment and learn to increase their efficacy. Responsibility and accountability are important elements of management and their contribution to the success of any task is immense. They provide the necessary stimuli for human beings to perform at their fullest capacity but are relatively difficult to measure and

control and hence to be developed as a culture at every level of management. The management should take up the responsibility of shaping the future of the students and provide the necessary input to meet the requirement of each student.

Lack of role clarity confuses employees on their task responsibilities.

Programme Requisites

Total quality education requires the support of infrastructure and teaching aids, suitable course plan and curriculum, benchmarking and identification and meeting of customer demands.

Infrastructure and Teaching Aids

Infrastructure facility plays a significant role in facilitating and promoting better education. It provides the necessary working environment both for the teachers as well as the students. Lack of facilities is a handicap in transmitting knowledge and imparting skills and reduces the morale and spirit of the teacher and involvement of the students. Teaching is ineffective in a congested and controlled environment and it is essential that teachers and students have easy access to information and facilities. A library with good collection of books, journals, back volumes of materials and easy ready reference with round the clock service, enough computer and Internet facilities, convenient class rooms and accommodation for the students, availability of modern technology and teaching aids like overhead projector, power point, audio visual aids etc. help quality education. It is not only the availability of the facility but also the liberty of the teacher to make use of them liberally with bureaucracy and procedures not standing in the way. However, many institutions in India today are inadequate in providing these facilities which is being reflected in the output quality.

Customer Demand

The education system has to effectively meet the demands of the internal and external customers and satisfy their needs fully. It is essential to identify the requirements of the internal customers to meet the requirements of the external customers. The task of integrating the interest of both the customers is integral to achieve TQE. The knowledge economy is growing along with the changes taking place in the socio, economic and political arena. The changes in the corporate sector bring about many changes in their human resource demand. Student requirements are also changing with the change in the market. The education sector should be sensitive enough to absorb these changes in the environment and introduce modifications, alterations or adjustments in the system. It is important that the demand of the environment and the supply by the education sector should go hand in hand. Today many institutions are finding it difficult to integrate the interest of these two customers as they fail to cope with the changes, throwing the future of the internal customers in jeopardy.

Course Plan and Curriculum

Course Plan and a suitable curriculum are key issues in providing quality education. The course plan comes from institutional objectives and the internal and external customers' demand. Then the curriculum is designed to meet the course objectives. This is possible by monitoring the external environment and making necessary modifications in the system. This calls for a close coordination between the institutions within and outside the educational system. The better the course plan and curriculum, closer the student with the external customer demand. Educational institutions should have the freedom to design the course plan and the curriculum on the basis of market needs and student requirement. Today the liberty is not available to many institutions and they are following a given scheme not revised for many years. It is desirable that central or state agencies cater to only the overall administration and control.

Educational institutions should have the freedom to design the course plan and the curriculum on the basis of market needs and student requirement.

Benchmarking & Continuous Improvement

Benchmarking is the continuous process of comparing a institution's strategy, facilities, process and student performance with those of market leaders and best in the field in order to learn how they achieved excellence and setting out to match and even surpass it. For many institutions, benchmarking has become a key component of their TQM programmes. Benchmarking evolved in 1950's when W. Edwards Deming taught the Japanese the idea of quality control. The method got momentum when Xerox, Motorola and IBM became the pioneers. Benchmarking helps in cultural

change, performance improvement and human resource development by providing basis for training. Educational institutions should undertake benchmarking to know their status; this would help them to identify the gap between the institution and the best in the field in terms of management, facilities, human resources, student requirements, and strategies and the necessary action to be undertaken towards total quality.

Human Resource Development

Role of teachers is paramount in achieving quality education. The teaching community has to play a pivotal role in shaping the future generation and act as role model for the students to follow.

Selection and Training

Unlike the corporate sector, the education sector deals purely with people and requires a strong human resource base. Human minds need to be overhauled at regular intervals in order to recharge the brain and update knowledge and skills. With the change in the external environment, teachers should update themselves to cope with the changing demands and requirements of students. A competency based human resource is to be built by selection based on merits,

The teachers are the inputs, students being the output in the education system. One cannot produce a quality product with a mediocre input.

performance assessments, training need assessment and matching of competencies required. Training and development of teachers should be one of the highest agenda of educational institutions as the teachers are the inputs, students being the output in the education system. One cannot produce a quality product with a mediocre input. Institutions do not generally hire people capable of teaching true skills. Now the Ph.D degree is the license to teach in a management institution. But the degree neither preselects nor trains for skills in pedagogy, certainly not of the experiment kind. The Ph.D is a research degree, and in good part it attracts introverts, people who want to bury themselves in a library or under a stack of data (Minzberg, 1989). It does not mean Ph.D is undesirable, the selection policy should see things beyond the degree.

The Ph.D degree is the license to teach in a management institution. But the degree neither preselects nor trains for skills in pedagogy, the selection policy should see things beyond the degree.

Employee Empowerment and Team Work

Empowerment is delegation of power and control, decentralisation of decision making, participative management, employee involvement, creating conditions for heightened motivation, enhancing feelings of self-efficacy. Employee involvement has been found to increase job satisfaction and increase productivity and reduce costs. Empowered workforce is better able to provide high quality customer service. Empowerment has been found to be a prerequisite for quality focused organisations. Since there is a close relationship between empowerment and performance of employees, it is important for the education system to provide teacher empowerment. The present education system involves inter-disciplines and cross-functional knowledge and orientation. This demands better coordination and teamwork among peers and also upward and downward levels of management. In order to accomplish the task qualitatively, the management may put ad hoc teams to address specific cross-functional and inter- disciplinary issues. These teams are generally temporary to the structure and may be revised when the need arises.

Dedication and Commitment

Employee involvement has been found to be a core value of TQM effort and has congruence with TQM. Dedication and commitment are the key for the success of any venture. These qualities gain more importance in the service sector, particularly the education field as the actual assessment and evaluation of both the input and output is tough. It is basically the trust and faith in the teaching community that runs our education system. Though there is some feedback system it is hard to assess how effective the teacher is on and off the classroom. The teacher has a significant role as a facilitator off the classroom too to help the students. Moreover, the teacher alone knows how far they are fair or biased in discharging the duty. The attitude and behaviour of the teacher while dealing with various students also matters. Many issues concerning teachers are very difficult to measure, verify and check. Instilling dedication and commitment in the teaching community is paramount to root out many of the issues confronting the education sector today. Promotion of institutional culture, combined with training and motivation will help

nurture dedication and commitment.

Student Orientation

Student orientation is the most important task towards total quality education. The orientation helps the students to relate themselves with the actual environment and go close to the realities. This orientation has to be done constantly on the basis of the feedback collected from the internal and external customers, teachers and parents.

Knowledge and Skill Development

Typical Indian managers have preconceived notions about the best way of doing business. Managers must possess the humility to learn and in some cases relearn. Indian managers are still unaware of the fact that low cost of production is not the only criterion for success in global market. This is true of PSUs. Often a simple task takes a long time to get done due to a set of baffling extraneous factors. This is a major handicap for Indian managers. To counter and eliminate these criticisms, the system needs to develop strategies to improve the knowledge and skill of the students.

Generally, present education system mainly focuses on the knowledge development part and there is little emphasis on skill improvement. Knowledge without skill could be of little use since execution of knowledge demands skill. Better focus has to be made on the skill development of students by identifying the inherent skills and interests of students. The present mark-oriented education is causing severe damage to skill development by only creating bookworms. The teaching methodologies also need drastic change as they fail to provide any scope for skill improvement. Teaching followed at IIMA brings ground realities to the classroom environment and provides students with skills for finding solutions to various issues by changing their roles (role play).

Field Visits and Training

Today the gap between the industry and education system is so wide that what one studies in the classroom hardly matches with the industrial practice. As the socio, economic and business environment keeps changing, the situation becomes more complex. Simple classroom reaching alone would not help students to enrich their knowledge to meet the current demands of the employment market. Students need to be exposed to various ground realities so as to enable them to understand how their classroom knowledge is practiced in the field. This calls for field visits at regular intervals and training in the field for some time in order to orient the students to the situation. This would significantly help the students go close to reality and help in career choice.

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Key Factors

In order to have a student-oriented approach, institutions should practise the following elements.

- Understanding student requirements
- Orientation derived from student requirements
- Proactive student service system
- Proactive management, teacher and student relationship
- Strategic infrastructure support
- Attention to practical training, field visits and field placements
- Regular seminars, group discussion, debates and GK tests
- Quality requirement of the market/industry

Total Quality Education: Implementation

Despite its popularity and widespread implementation, there is considerable confusion about TQE. Part of the contradiction in the current literature could be attributed to the absence of a global definition of quality. But it can be said that quality education must enrich one's knowledge and skill. According to Edwards Deming, "good quality does not necessarily mean high quality, it means a predictable degree of uniformity and dependability at low cost with a quality suited to the market".

The record of successful realization of TQE's is dismal. In a large majority of the cases, failure is attributed to problems encountered during the implementation process. For effective implementation of TQE in an institution, the following features are pre-requisites.

- Alignment within the institution and commitment to a shared vision

- An extended understanding of the customer-driven and process oriented basis for quality
- An institution designed around teams and changes made in performance management to reflect teamwork as the basis for organisational activities
- The setting of challenging goals, which commit the institution to significant increase in performance outcomes
- The systematic daily management of the institution through the use of effective tools for measurement and feedback.

Conclusion

Total Quality Education (TQE) is not a result of accident or gimmicks; it demands a great deal of commitment and continuous effort. TQE is a management philosophy that builds students-driven learning or an organisation dedicated to total student satisfaction with continuous improvement in the effectiveness of the organisation and its processes. American Quality Gurus like Edward W. Deming and Joseph M. Juran made quality a national movement to build the industrial economy of Japan during their repeated visits to Japan (Gen. S.K. Bhatnagar, 1999). The result of their effort is strongly visible now. Japan is the top economic power in the world today surpassing the so-called economic power center, the United States of America, raising from the dust of the second world war. The credit for this achievement can be attributed to the quality movement in Japan. Our resources and strengths have to be directed to spread quality wave in the education sector, the vital sector for the prosperity of the citizens and nations. The TQE model discussed in this article may be of some use in this journey.

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The strongest principle of growth lies in human choice.

– Mary Ann Evans

Feature

Economics of Engineering Industry in Kerala

Ashita Raveendran

Emphasis is often placed on the promotion of engineering industry as a propulsive force for attaining industrial development. Identification of the critical constraints in the expansion of this vital sector is thus of relevance for policy making. The article presents a survey on the capital structure and input use efficiency of the Engineering industry in Kerala. In general, the findings illustrate the use of obsolete technology and low input use efficiency. In light of these findings, the article discusses the general implications.

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Industrialization contributes to economic development. Hence there is a general consensus on the need for accelerating the pace of industrial growth as a means to achieve overall economic development of a region. Speedy industrialization can be achieved only if the basic industries are suitably planned and started. Engineering industry products which include basic metal & alloys, metal products, machinery products, electrical equipment and transport equipment play a pivotal role in this direction since they are the major suppliers of necessary components for other industries.

Speedy industrialization can be achieved only if the basic industries are suitably planned and started.

A higher investment rate in the investment goods sector would mean a higher investment rate at the margin and hence a greater rate of growth of output. More steel per person means more machinery per person which translates into more production per person (Mahalanobis 1955). In this context, the present investigation analyses the structure and productivity of the engineering industry in Kerala for the period between 1988-98.

Statement of the problem

Studies on industrialization in Kerala acknowledge the state's industrial backwardness but have put forward different hypothesis for this lag namely, labour disturbance hypothesis, wage cost hypothesis, psychic-cost hypothesis, Jajmani hypothesis and industrial structure hypothesis. Scholars who favour the industrial structure hypothesis opine that the slow industrial growth in the state could be explained by endogenous factors resulting from the process of historical development of industry in a lopsided structure rather than by exogenous differences in resource

endowment. The hypothesis stated in earlier studies which suggests that the inadequate development of demand based industries and capital goods industries (engineering) has led to the industrial stagnation in Kerala indicates that there is reasonable potential for engineering goods in the state which are now mainly met by imports. The development of engineering industry in Kerala is rudimentary and domestic demand is largely met by imports. It accounts for only 1.45 per cent of the total factories with a productive capital of 1.03 per cent, 1.30 per cent of employees, 0.77 per cent of output and 1.10 per cent of net value added of total engineering industry in India for the year 1995-96. Even though the engineering industry had to play a legitimate role in the state, it has not initiated the required part. But at the same time, even the limited supply is transferred to the other states mainly because the available designs are not in tune with domestic demand. In short, contradictions and mismatch are observed in the demand and supply conditions. This mismatch between demand and supply has led to uneconomic operation of many of the engineering units. Even with much scope for engineering industries in Kerala, the existing industries find it hard to grapple with the many constraints that affect effective functioning.

Contradictions and mismatch are observed in the demand and supply conditions. This has led to uneconomic operation of many engineering units.

Studies on engineering industries are very rare of which majority pertain to aspects like trends and prospects (Majumdar 1962), export performance, (Dinesh Trehan 1970; Sanjaya Lal and Rajiv Kumar 1981; Kumar Mahadevan 1981; Patibandla 1988; Lajpathi Raj and Janardana Sastri 1989; Sada Shankar 1990; Suvrathan 1991; Agarwal and Goldar 1999; Jojo Jacob 1999), rate of return (Ranjit K. Sau 1970), spatial dimension (Suranjit K. Saha 1993) and linkages (Usha 1992). These studies have analysed industries performance in the country and do not make any references to its situation within the states. Hence, a study of the economic structure and production function in engineering industry of Kerala is essential. There is the need to study the industry's internal efficiency, which ultimately shall determine overall industrial development in future. The present study therefore makes an attempt to discuss the economics of engineering industry by analyzing the sample units consisting of 4 groups, viz, metal product group, machinery group, electrical group and transport equipment group.

Methodology

Engineering industry is primarily a metal using industry, though other materials like plastics, nylon, rubber etc are also used as inputs. The industry includes basic metals and alloys (group 33), metal products (group 34), machinery (group 35), electrical (group3 6) and transport equipment (group 37) as defined by the Central Statistical Organisation. The definition of AIEI includes the industry 16 NSC groups. But the scope of engineering industry in this discussion is limited to 4 groups only, viz, metal product group (34), machinery group (35), electrical group (36), and transport equipment group (37) because of the difficulty in perfect demarcation of the units. As the heavy engineering industries require large capital investment they are confined to a small number of giant enterprises. In Kerala, there exist only a few modern private owned engineering industries and that too, which started production after 1990. Therefore, this discussion is confined to the small-scale sector.

The database of this paper represents a sample of small-scale industries registered with the state directorates of industries and come under the purview of Small Industries Development Organisation (SIDO). The sample units were drawn from across the state giving due weightage for regional concentration. More than 80 per cent of the sample units were set up since 1980. This was due to the industrialization efforts made by the state government in recent years. However, three sample units selected from southern region had a very old tradition. The entire sample units are currently under individual proprietorship. Two sample units were started as partnership firms but later converted into sole proprietorship due to family obligations.

The methodology adopted is both descriptive and analytical. The economics of the industry is studied by the detailed examination of capital structure, inputs used including labour, product mix, value of output, market, profit and value added. Structural changes over the reference period are discussed with the help of selected structural ratios namely, fixed capital to invested capital ratio, fixed capital to productive capital ratio, input output ratio, value added to output ratio, fixed capital to output ratio, invested capital to output ratio, value added to invested capital ratio, value added to input ratio, output input ratio, output invested capital ratio and input invested capital ratio. The study also makes use of Cobb-Douglas and Translog production functions to check the factor contributions. To check the validity of Cobb-Douglas results, Cobb-Douglas function was estimated at the macro level using ASI data for neighbouring states.

Table 1: Capital Structure

(Rs in Lakhs)

Year	Fixed Capital (per Unit)					Invested Capital (per Unit)					Working Capital (per Unit)					Productive Capital (per Unit)				
	Metal	Machi-nery	Electri-cal	Trans-port	Engi-neer-ing	Metal	Machi-nery	Electri-cal	Trans-port	Engi-neer-ing	Metal	Machi-nery	Electri--cal	Trans-port	Engi-neer-ing	Metal	Machi-nery	Electri-cal	Trans-port	Engi-neer-ing
1988	8.44	2.65	1.64	16.81	29.55	9.63	3.71	3.10	18.79	35.22	0.21	0.96	0.28	0.04	1.53	8.66	3.60	1.92	16.90	31.08
1989	9.27	2.55	1.63	18.75	32.19	10.87	4.29	2.92	20.76	38.84	0.13	2.14	0.24	0.02	2.53	9.40	4.69	1.88	18.76	34.73
1990	8.60	2.72	1.60	20.57	33.49	10.95	4.19	3.37	22.71	41.23	0.17	–0.05	0.32	0.02	0.45	8.77	2.66	1.93	20.59	33.95
1991	7.66	2.46	1.51	21.19	32.83	10.09	5.69	4.95	23.19	43.91	0.16	1.40	0.97	–0.31	2.22	7.83	3.86	2.49	20.88	35.06
1992	6.93	2.42	1.63	22.25	33.22	10.16	9.36	5.40	24.35	49.27	0.14	6.13	0.56	0.02	6.85	7.06	8.55	2.19	22.27	40.08
1993	6.43	2.68	2.95	24.47	36.53	10.66	17.42	7.85	27.36	63.30	0.26	5.49	0.74	0.14	6.63	6.69	8.18	3.69	24.61	43.17
1994	5.99	2.50	2.80	25.71	37.01	10.22	9.43	9.38	29.25	58.28	0.33	5.49	0.40	0.66	6.88	6.32	7.99	3.20	26.37	43.88
1995	5.48	2.22	2.97	26.18	36.84	7.36	7.14	10.56	28.81	53.87	0.36	6.63	–0.59	0.16	6.57	5.84	8.85	2.39	26.34	43.41
1996	6.18	2.41	2.86	26.31	37.77	9.33	6.31	13.04	28.14	56.83	0.42	5.82	2.47	0.13	8.84	6.60	8.23	5.34	26.45	46.61
1997	6.11	3.40	3.66	26.54	39.71	10.80	6.32	14.05	28.72	59.90	0.46	6.26	4.30	0.55	11.58	6.57	9.66	7.97	27.09	51.29
1998	5.63	3.54	6.46	27.05	42.69	8.80	8.55	19.69	29.07	66.10	0.28	6.69	0.62	0.13	7.72	5.91	10.23	7.08	27.18	50.41

Source: Survey Data.

Empirical Results & Findings

Capital Structure

Capital structure consists of fixed capital, physical working capital, working capital, invested capital and productive capital. The examination of the trends in fixed capital of the four engineering groups shows that significant changes have not taken place in the composition of fixed capital in the metal product group and it is seen that generally firms refrain from incurring much expenditure on items of fixed capital once they are established. For the machinery group, there has been significant changes in the share of land and building and plant and machinery over the years. Marginal increase in the fixed capital of transport and electrical groups is seen in recent years. This is to some extent a consequence of the urge for industrialization and the significant linkages of this group to total industrialization. The invested capital which is composed of fixed capital and physical working capital points to the increasing tendency of the units to store materials. Among the groups, the inventory (stocking of goods) was found to be maximum in the electrical group and minimum in transport group. The increase in invested capital per unit during the period 1988-98 in the electrical, machinery, transport groups were respectively 5.36 times, 1.31 times and 0.55 times. In all the four groups, working capital is reasonably low due to the high financial commitments. Details indicate that loan commitments are maximum in the metal product group and least in machinery group. Increase in the per unit working capital in the machinery, electrical, transport and metal product groups was to the tune of 5.98 times, 1.23 times, 2.99 times and 0.33 times. Productive capital is the sum total of fixed capital and working capital. The productive capital per unit of engineering industry came to Rs 3107720 in 1988 which increased to Rs 5040585 in 1998, the percentage growth over the period being 62.46 per cent. There has been a decrease in productive capital of metal product, which further strengthens the view that factories in general once established do not incur much expenditure for any of the fixed capital items. It is also seen that among the groups, productive capital is maximum for transport group followed by metal product and machinery groups. But in the terminal year the major contributor is transport group, followed by machinery and electrical groups. The shift from metal product group to machinery and electrical groups may be due to the change in industry demands. However, the broad trends in the behaviour of productive capital are in tune with the behaviour of other capital items. Considering the various dimensions of the behaviour of capital we may infer that among the groups, the capital structure of transport group and electrical group are significant (Table 1).

Loan commitments are maximum in the metal product group and least in machinery group.

Table 2: Employment in Sample Units of different engineering groups (1988 to 1998)

Year	Metal product group			Machinery group			Electrical group			Transport group		
	Perma-nent	Tempo-rary	Total	Perma-nent	Tempo-rary	Total	Perma-nent	Tempo-rary	Total	Perma-nent	Tempo-rary	Total
1988	48	20	68	12	20	32	45	42	87	35	44	79
1989	60	16	76	20	16	36	45	40	85	40	45	85
1990	64	16	80	25	17	42	46	40	86	40	50	90
1991	70	16	86	27	20	47	52	32	84	43	63	109
1992	78	20	98	30	22	52	52	28	80	45	65	110
1993	80	20	100	30	19	49	50	22	72	45	38	83
1994	82	18	100	36	23	59	50	30	80	47	40	87
1995	86	18	104	40	23	63	50	33	83	47	44	91
1996	90	20	110	42	20	62	63	20	83	47	48	95
1997	96	16	112	50	45	95	65	50	115	49	50	99
1998	96	20	116	50	40	90	65	13	78	54	50	104

Table 3(a): Per unit Cost of Production of Metal products (1988-1998)

[in Rs]

Year	Raw material & stores	Wages & Salaries	Other operating cost	Power & Fuel cost	Total
1988	161397	77432	73232	10683	322744
1989	154545	93805	78117	15537	342005
	(–4.25)	(21.14)	(6.67)	(45.44)	(5.97)
1990	443439	134372	92038	16152	686001
	(186.93)	(43.25)	(17.82)	(3.96)	(100.58)
1991	584302	193538	199775	15774	893389
	(31.77)	(44.03)	(8.41)	(–2.34)	(30.23)
1992	1021426	208721	126148	20895	1377189
	(74.81)	(7.84)	(26.43)	(32.46)	(54.15)
1993	1184114	294666	147027	19261	1645068
	(15.93)	(41.18)	(16.55)	(–7.82)	(19.54)
1994	1358120	259419	197881	21437	1836857
	(14.69)	(–11.96)	(34.59)	(11.30)	(11.66)
1995	1753980	417700	251768	23088	2446537
	(29.15)	(61.01)	(27.23)	(7.70)	(33.19)
1996	1484316	373073	208327	28397	2094112
	(–15.37)	(–10.68)	(–17.25)	(23.00)	(–14.41)
1997	1517617	570510	312452	27089	2427667
	(2.24)	(52.92)	(49.98)	(–4.61)	(15.93)
1998	258650	745578	411260	32630	3698118
	(65.30)	(30.69)	(31.62)	(20.46)	(52.33)

Source: Survey Data.

Figures in brackets give percentage change over the previous year.

Table 3(b): Per unit Cost of Production of the Machinery group (1988-1998)

[in Rs]

Year	Raw material & stores	Wages & Salaries	Other operating cost	Power & Fuel cost	Total
1988	1206579	212429	210683	11635	1641325
1989	2078747	225169	382700	13127	2699743
	(72.28)	(6.00)	(81.65)	(12.83)	(64.49)
1990	2149000	237891	192121	16117	2595130
	(3.38)	(5.65)	(–49.80)	(22.78)	(–3.87)
1991	1736418	239309	353903	16141	2345770
	(–19.20)	(0.69)	(84.21)	(0.15)	(9.61)
1992	1930930	270802	485258	17542	2704531
	(11.20)	(13.16)	(37.12)	(8.68)	(15.29)
1993	1481873	288589	629004	20783	2420248
	(–23.26)	(6.57)	(29.62)	(18.48)	(–10.51)
1994	3295697	280467	534461	19353	4129978
	(122.40)	(–2.81)	(–15.03)	(–6.88)	(70.64)
1995	3235459	434257	456926	24627	4151269
	(–1.83)	(54.83)	(–14.51)	(27.25)	(0.52)
1996	3373702	448920	653046	26808	4502476
	(4.27)	(3.38)	(42.92)	(8.86)	(8.46)
1997	2967368	781176	1721657	28502	5515369
	(–12.04)	(74.01)	(163.63)	(6.32)	(22.50)
1998	4061881	745202	2211283	30662	7049028
	(36.88)	(–4.61)	(28.44)	(7.58)	(27.81)

Source: Survey Data.

Figures in brackets give percentage change over the previous year.

Table 3(c): Per unit Cost of Production of the Electrical group (1988-1998)

[in Rs]

Year	Raw material & stores	Wages & Salaries	Other operating cost	Power & Fuel cost	Total
1988	600031	221844	14724	7507	844105
1989	744447	210658	15304	8156	978564
	(24.07)	(-5.04)	(3.94)	(8.64)	(15.93)
1990	563692	218482	17373	11979	811526
	(-24.28)	(3.71)	(13.53)	(46.87)	(-17.07)
1991	917956	430240	33572	7986	1389754
	(62.85)	(-80.16)	(93.24)	(-33.33)	(71.25)
1992	1056944	387628	25701	8090	1478363
	(15.14)	(-9.90)	(-23.44)	(91.30)	(6.38)
1993	1404310	357570	35848	7296	1805024
	(32.87)	(-7.75)	(39.48)	(-9.82)	(22.10)
1994	1442919	448795	66004	9842	1967559
	(2.75)	(25.51)	(84.12)	(34.91)	(9.00)
1995	1771936	377906	58360	14897	2223098
	(22.80)	(-15.80)	(-11.58)	(-51.36)	(12.99)
1996	3079854	664644	59042	23804	3827343
	(73.81)	(75.88)	(1.17)	(59.79)	(72.16)
1997	3606419	833499	72818	27620	4540356
	(17.10)	(25.41)	(23.33)	(16.03)	(18.63)
1998	2822067	468913	76057	28891	3395927
	(-21.75)	(-43.74)	(4.45)	(4.60)	(-25.21)

Source: Survey Data.

Figures in brackets give percentage change over the previous year.

Table 3(d): Per unit Cost of Production of the Transport group during the period 1988-1998

[in Rs]

Year	Raw material & stores	Wages & Salaries	Other operating cost	Power & Fuel cost	Total
1988	1573610	93078	217908	85426	1970022
1989	1793566	128658	227512	93107	2242843
	(13.98)	(38.23)	(4.41)	(8.99)	(13.85)
1990	1836695	147975	248772	99337	2332779
	(2.40)	(15.01)	(9.34)	(6.69)	(4.01)
1991	2294626	180765	276427	104592	2856410
	(24.93)	(22.16)	(11.12)	(5.29)	(22.45)
1992	2287608	192431	303061	114055	2897156
	(-0.31)	(96.45)	(9.64)	(9.05)	(1.43)
1993	1965592	112430	236354	100828	2415204
	(-14.08)	(-41.57)	(-22.01)	(-11.60)	(-16.64)
1994	4183221	212812	400803	126253	4923090
	(112.82)	(89.28)	(69.58)	(25.22)	(103.84)
1995	4851752	271716	521755	152920	5798142
	(15.98)	(27.68)	(30.18)	(21.12)	(17.77)
1996	5349059	378881	566782	187233	6481956
	(10.25)	(39.44)	(8.63)	(22.44)	(11.79)
1997	5069142	465671	411775	170451	6117039
	(-5.23)	(22.91)	(-27.35)	(-8.96)	(-5.63)
1998	7230115	623330	901114	247349	8968574
	(42.63)	(33.86)	(118.84)	(45.11)	(46.62)

Source: Survey Data.

Figures in brackets give percentage change over the previous year.

Employment

Labour absorption is found to be maximum in metal product group. The share of permanent employment in the case of machinery, electrical and transport groups is relatively low mainly due to the specific skills required for the job. The employment pattern shows that there exists a clear gender bias in favour of males in metal, machinery and transport groups. Due to the nature of the job, female employment was found to be significant in the case of electrical group (Table 2).

There exists a clear gender bias in favour of males in metal, machinery and transport groups.

Cost of Production

Cost of production consists of raw materials and stores, wages and salaries, other operating cost and power and fuel cost (Tables 3 (a) (b) (c) & (d)). There is significant escalation in the cost of engineering industry over the years which is consistent with the other industries also. In all the groups, the cost of raw materials constitutes the major share. This is definitely due to the nature of raw material and also due its supply from other states. Hence the cost effectiveness of engineering industry in Kerala depends exclusively on cost control over raw material. Among the groups, rise in raw material cost was more in the metal product group. The output of the metal product group constitutes the major input of the machinery group suggesting linkages. The major raw materials of the electrical group are electrical components, battery water, battery components etc. The traditionally accepted high cost factors like labour cost and fuel cost play only a nominal role in the cost of

Table 4: Value of Output per unit of different engineering groups during the period 1988-1998

[in Rs]

Year	Metal Product group	Machinery group	Electrical group	Transport group	Engineering industry
1988	425015	1967232	1162917	2645027	6200192
	(6.85)	(31.73)	(18.76)	(42.66)	(100)
1989	616711	3104644	1243218	2759145	7723718
	(7.98)	(40.20)	(16.10)	(35.72)	(100)
1990	1027299	2971433	1177297	2892593	8068622
	(12.73)	(36.83)	(14.59)	(35.85)	(100)
1991	1225677	3088526	1701714	3223803	9239720
	(13.27)	(33.43)	(18.42)	(34.89)	(100)
1992	1414420	3392713	1681156	3637965	10126255
	(13.97)	(33.50)	(16.60)	(35.93)	(100)
1993	1820085	3158803	1901399	3240342	10120629
	(17.98)	(31.21)	(18.79)	(32.02)	(100)
1994	2145202	4931624	2366515	6883931	16327273
	(13.14)	(30.20)	(14.49)	(42.16)	(100)
1995	2636874	4637757	3048493	7816098	18139221
	(14.54)	(25.57)	(16.81)	(43.09)	(100)
1996	2238406	5032474	4977037	8113076	20360994
	(10.99)	(24.72)	(24.44)	(39.85)	(100)
1997	2942346	6312896	4892875	7543624	21691741
	(13.99)	(30.03)	(20.10)	(35.88)	(100)
1998	4510510	7695176	4008606	10321872	26536164
	(17.00)	(29.00)	(15.11)	(38.90)	(100)

Source: Survey Data.

Figures in brackets give percentage share of each group.

Table 5: Gross Profit of the sample units during the period 1988 to 1998

(Rs in lacs)

Year	Metal product group	Machinery group	Electrical group	Transport group1988
1989	24.72	24.29	15.89	30.93
1990	30.76	22.58	21.91	33.63
1991	29.90	44.57	18.71	22.02
1992	3.37	41.29	12.20	44.47
1993	15.74	44.31	5.80	49.49
1994	27.78	48.10	23.95	117.70
1995	17.11	29.19	49.52	121.11
1996	13.03	31.80	68.96	97.88
1997	46.31	47.85	1.18	85.40
1998	73.10	38.76	36.74	81.19

Source: Sample Data.

production of machinery group because of the very nature of the group.

Cost effectiveness of engineering industry in Kerala depends exclusively on cost control over raw material.

In the electrical group, it is observed that over the years, the share of labour cost has considerably come down. This may either be due to labour displacement or female labour absorption in recent years. The trends in the behaviour of cost components of transport group are at par with the other groups. An interesting observation in the cost behaviour of the transport group is the very low share of wages and salaries. It constitutes only 4 per cent of the total cost of production. This trend is due to the more number of temporary hands in the transport group.

From the discussion three major inferences are derived with respect to the cost of production.

- There is significant cost escalation in the different groups of engineering industry over the years which are consistent with the other industries also.
- In all the groups, the cost of raw material constituted the major share. Hence any measure to strengthen the engineering industries should be centered around scientific raw material management.

Any measure to strengthen the engineering industries should be centered around scientific raw material management.

- Contrary to the general trends, the role of fuel cost and emoluments is low in various groups of engineering industries. Low share of permanent employees and the nature of production process contributed towards this.

Value of output

The output composition of different groups shows that even within each group and unit, there exist product heterogeneity. This makes intra and inter comparisons difficult. The value of output made a notable

increase over the period of time (Table 4). The value of output per unit of sample amounted to 62 lakh in 1988, the percentage contribution from metal, machinery, electrical and transport groups respectively being 42.60 per cent, 18.76 per cent, 31.73 per cent and 6.85 per cent. Throughout the reference period, almost the same trend continued. The value of output of the different groups namely metal product, machinery, electrical and transport groups multiplied by 9.61 times, 2.91 times, 2.44 times and 2.90 times. Among the groups, the metal group has the prominent position whose value of output has gone up by 9.61 times. But as the information on output is exclusively in value terms, precise inference cannot be drawn as it may happen due to price escalation which is linked to the nature and use of the product. The value of output is also related to the width and depth of the market. During the course of the study, it was observed that in the case of metal, electrical and transport groups, 70 to 80 per cent products are demanded within the state. The likely reason for this trend is manufacturing of the required item only after getting the order. But in the case of machinery group, they are mainly demanded in other states particularly Karnataka and North Indian states. This trend is the result of slow and lopsided industrialisation of the state. Certain products of these groups cannot find market in the state and on the other hand, the units, because of various constraints, cannot supply certain items demanded by the Kerala industrialists. This also indicates the absence of inter industry linkages which limits rapid industrialisation.

Profit

The prosperity of industry depends on the margin of profit earned. There are fluctuations in the behaviour of gross profit over the reference period (Table 5). These fluctuations are mainly due to price variations of raw materials, because selling price is determined in the market considering local factors and in many cases, this is not in tune with the cost of raw materials.

Value Added

Value added is one of the important indicators reflecting the contribution of the industries (Table 6). The trends in value added are significant in recent years in the context of liberalization and the resultant export led growth. Across the groups, value addition is high in the case of machinery and transport groups because of their inherent nature.

Structural Ratios

So far, the economics of the four groups of engineering industry was analysed with conventional variables like capital, input, output, profit and value added. But the picture will be more revealing when these variables are interrelated with the help of structural ratios. Structural ratios help to evaluate the extent of capital use, labour use, technology and to some extent input use efficiency (Table 7 (a), (b), (c) & (d). Examination of the structure of the four engineering groups with the help of selected ratios leads to the following findings:

- Fixed capital-invested capital ratio and fixed capital productive capital ration show that capital intensity was high in earlier years for the metal and machinery groups but has declined over the years. The ratios were found to be higher in transport and increasing in the electrical group. This was due to attempts at modernisation. The fall in capital intensity is further illustrated by the behaviour of fixed capital output ratio also.
- Continuous increase in the cost of inputs was revealed by the input output ratio. The rise in the cost of inputs is mainly due to the increased

Table 6: Value Added per unit of the sample units of different Engineering groups during the period 1988-1998

Year	Metal Product group	Machinery group	Electrical group	Transport group	Engineering Industry
1988	252935	749019	627390	985992	2615336
	(9.67)	(28.64)	(23.99)	(37.70)	(100)
1989	446628	1012770	490616	872472	2822486
	(15.82)	(35.88)	(17.38)	(30.91)	(100)
1990	567708	806316	601627	956560	2932210
	(19.36)	(27.50)	(20.52)	(32.62)	(100)
1991	625601	1335967	775773	824585	3561925
	(17.56)	(37.51)	(21.78)	(23.15)	(100)
1992	372099	1444241	616123	1236302	3668765
	(10.14)	(39.37)	(16.79)	(33.70)	(100)
1993	616710	1656148	489793	1173921	3936572
	(15.67)	(42.07)	(12.44)	(29.82)	(100)
1994	765646	1616574	913755	2574457	5870432
	(13.04)	(27.54)	(15.57)	(43.85)	(100)
1995	859806	1377671	1261660	2811426	6310563
	(13.62)	(21.83)	(19.99)	(44.55)	(100)
1996	725694	2298630	1873380	2576784	7474487
	(9.71)	(30.75)	(25.06)	(34.47)	(100)
1997	1397640	3300360	592169	2304031	7594200
	(18.40)	(43.46)	(7.80)	(30.34)	(100)
1998	1969230	3602634	1157648	2844409	9573921
	(20.57)	(37.63)	(12.09)	(29.71)	(100)

Source: Survey Data.

Figures in brackets give percentage share of different Engineering groups.

Table 7(a): Structural Ratios of the Sample Units (Metal Products) during the period 1988 to 1998

Year	Fixed Capital to Invested Capital	Fixed Capital to Productive Capital	Input Output Ratio	Value Added Output Ratio	Fixed Capital to Output	Invested Capital to Output	Value Added to Invested Capital	Output per Worker	Input per Work	Value Added per Worker	Value Added in Input	Output Input	Output Invested Capital	Input Invested Capital
1988	0.88	0.29	0.4	0.6	1.99	2.27	0.26	56251.90	22779.40	3476.71	1.47	2.47	0.44	0.18
1989	0.85	0.29	0.28	0.72	1.50	1.76	0.41	73031.55	20144.70	52890.21	2.63	3.63	0.57	0.16
1990	0.79	0.27	0.45	0.56	0.83	1.07	0.51	115571.51	51700.0	63867.14	1.24	2.24	0.94	0.42
1991	0.76	0.29	0.49	0.51	0.63	0.82	0.62	128268.50	48093.0	65469.85	1.04	2.04	1.22	0.60
1992	0.68	0.29	0.74	0.26	0.49	0.72	0.37	129895.00	95724.50	34172.37	1.60	1.36	1.39	1.03
1993	0.60	0.28	0.66	0.34	0.35	0.59	0.58	163807.70	108300.0	55503.87	0.51	1.51	1.71	1.13
1994	0.59	0.28	0.64	0.36	0.28	0.48	0.75	185642.50	124160	68908.11	0.55	1.55	2.10	1.35
1995	0.75	0.30	0.67	0.33	0.21	0.28	1.17	215744.20	153788.50	74406.27	0.48	1.48	3.58	2.42
1996	0.66	0.24	0.68	0.32	0.28	0.42	0.77	183142.30	123763.60	59374.95	0.48	1.48	2.40	1.62
1997	0.57	0.23	0.52	0.48	0.21	0.27	1.29	236438.50	124125.00	112310.35	0.90	1.90	2.72	1.43
1998	0.72	0.26	0.56	0.44	0.14	0.20	2.24	362451.70	20421.30	152785.7	0.77	1.77	5.13	2.89

Source: Survey Data.

Table 7(b): Structural Ratios of the Sample Units (Machinery group) during the period 1988 to 1998

Year	Fixed Capital to Invested Capital	Fixed Capital to Productive Capital	Input Output Ratio	Value Added Output Ratio	Fixed Capital to Output	Invested Capital to Output	Value Added to Invested Capital	Output per Worker	Input per Work	Value Added per Worker	Value Added in Input	Output Input	Output Invested Capital	Input Invested Capital
1988	0.71	0.73	0.62	0.38	0.13	0.19	0.02	368856.06	228414.96	140441.09	0.38	1.61	5.31	3.29
1989	0.6	0.54	0.67	0.33	0.08	0.14	2.36	767440.61	348645.60	168794.97	0.48	1.48	7.24	4.88
1990	0.65	1.02	0.73	0.27	0.09	0.14	1.92	424490.42	309302.50	115187.97	0.37	1.37	7.08	5.17
1991	0.43	0.63	0.57	0.43	0.08	0.18	2.35	394279.90	223730.95	170548.93	0.76	1.76	5.43	3.08
1992	0.26	0.28	0.57	0.43	0.07	0.28	1.54	381466.90	224823.70	16643.23	0.74	1.74	3.62	2.08
1993	0.15	0.26	0.48	0.52	0.08	0.55	0.95	386792.24	183998.60	202793.70	1.10	2.10	1.81	0.86
1994	0.27	0.31	0.67	0.33	0.05	0.19	1.71	501521.80	337123.70	164397.40	0.48	1.49	5.22	3.52
1995	0.31	0.25	0.70	0.30	0.05	0.15	1.93	441691.10	310484.30	131206.80	0.42	1.42	6.50	4.57
1996	0.38	0.29	0.68	0.32	0.05	0.13	2.58	551529.70	329081.00	157931.96	0.48	1.47	7.97	6.20
1997	0.54	0.35	0.48	0.52	0.05	0.10	5.22	398709.20	190265.40	208443.80	1.10	2.10	9.99	4.77
1998	0.41	0.35	0.53	0.47	0.05	0.11	4.21	513011.70	272836.20	240175.60	0.88	1.88	9.00	4.79

Source: Survey Data.

transport cost that has to be met by all the engineering groups in the state because of locational diseconomies.

- Value added input ratio and value added output ratio declined over the years in the metal, electrical and transport groups indicating low input use efficiency. The ratio fluctuated over the years in the engineering groups, which strengthened the view that the prospects of this industry are subject to fluctuations.
- The declining value added output ratio in the metal, electrical and transport groups also shows the low contributions made by these groups. For the machinery group alone, there was a marginal increase in contribution.
- Input per worker, output per worker and value added per worker increased over the years as a result of price rise, which are only part of the economic changes that have taken place in the country over the years.

Table 7(c): Structural Ratios of the Sample Units (Electricaigroup) during the period 1988 to 1998

Year	Fixed Capital to Invested Capital	Fixed Capital to Productive Capital	Input Output Ratio	Value Added Output Ratio	Fixed Capital to Output	Invested Capital to Output	Value Added to Invested Capital	Output per Worker	Input per Work	Value Added per Worker	Value Added in Input	Output Input	Output Invested Capital	Input Invested Capital
1988	0.53	0.85	0.46	0.54	0.14	0.27	2.03	80201.17	36932.90	43268.30	1.17	2.17	3.76	1.73
1989	0.56	0.87	0.60	0.39	0.13	0.23	1.68	87756.59	53124.90	34631.70	0.65	1.65	4.26	2.58
1990	0.48	0.83	0.49	0.51	0.14	0.29	1.79	72137.00	40163.05	41973.95	1.04	2.05	3.49	1.71
1991	0.31	0.61	0.54	0.46	0.09	0.29	1.57	121551.02	163901.90	55412.40	0.84	1.84	3.44	1.87
1992	0.30	0.74	0.63	0.37	0.10	0.32	1.14	126086.70	171570.60	46209.20	0.59	1.58	3.11	1.97
1993	0.38	0.80	0.74	0.26	0.15	0.41	0.62	158449.90	163799.40	40816.10	0.35	1.35	2.42	1.78
1994	0.30	0.87	0.61	0.39	0.12	0.40	0.97	177488.65	108957.10	68531.60	0.63	1.63	2.52	1.55
1995	0.28	1.24	0.59	0.41	0.10	0.35	1.2	220372.98	129168.60	91204.40	0.71	1.71	1.69	2.89
1996	0.22	0.53	0.62	0.38	0.06	0.26	1.44	359785.23	224360.80	135425.02	0.60	1.60	3.82	2.38
1997	0.26	0.46	0.86	0.14	0.09	0.33	0.42	220497.80	189602.02	30895.80	0.16	0.16	3.01	2.59
1998	0.72	0.26	0.56	0.44	0.14	0.28	2.24	362451.70	204214.30	152785.70	0.77	1.77	5.13	2.89

Source: Survey Data.

Table 7(d): Structural Ratios of the Sample Units (Transport group) during the period 1988 to 1998

Year	Fixed Capital to Invested Capital	Fixed Capital to Productive Capital	Input Output Ratio	Value Added Output Ratio	Fixed Capital to Output	Invested Capital to Output	Value Added to Invested Capital	Output per Worker	Input per Work	Value Added per Worker	Value Added in Input	Output Input	Output Invested Capital	Input Invested Capital
1988	0.90	0.99	0.63	0.37	0.64	0.71	0.52	20088.10	126002.70	74885.50	0.59	1.59	1.41	0.88
1989	0.90	0.99	0.68	0.32	0.68	0.75	0.42	194763.20	133176.90	61586.30	0.46	1.40	1.33	0.91
1990	0.91	0.99	0.67	0.33	0.71	0.79	0.42	192839.60	129068.80	63770.70	0.49	1.49	1.27	0.85
1991	0.91	1.01	0.74	0.26	0.66	0.72	0.36	177457.10	132067.04	45389.98	0.34	1.34	1.39	1.03
1992	0.91	0.99	0.66	0.34	0.61	0.67	0.51	198434.50	130999.80	67434.70	0.51	1.51	1.49	0.99
1993	0.89	0.99	0.64	0.36	0.76	0.84	0.43	234241.60	149379.80	84861.80	0.57	1.57	1.18	0.75
1994	0.88	0.99	0.63	0.37	0.37	0.42	0.88	474753.90	297205.10	177548.80	0.60	1.60	2.35	1.47
1995	0.91	0.99	0.4	0.36	0.33	0.37	0.98	515347.10	329978.40	185368.70	0.56	1.56	2.71	1.74
1996	0.93	0.99	0.68	0.32	0.32	0.35	0.92	512404.80	349660.60	162744.20	0.47	1.47	2.88	1.97
1997	0.92	0.98	0.69	0.31	0.35	0.38	0.80	457189.30	317551.10	139638.20	0.44	1.44	2.63	1.82
1998	0.93	0.99	0.72	0.28	0.26	0.28	0.98	595493.60	431392.10	1641005.0	0.38	1.38	3.55	2.57

Source: Survey Data.

Production Function

The discussion in economics will be incomplete without a discussion on productivity trends. In a very lucid way, productivity is denoted by the ratio of output to any or associated inputs. Many studies in the past – Diwan-Gujarati (1968), Banerjee (1975), Ahulwalia (1985, 1991), Goldar (1986), Anitha Kumari (1993), Balkrishnan and Pushpangadan (1994), Chadha and Sanjeev (1994), Gajanan (1995), Baghol and Pendse (1996), Rao (1996) and more recently, Chattopadhyay and Bhadra (1998) and Kumar (2000) have tried to measure productivity at aggregate level as well as disaggregated level of industrial manufacturing pertaining to different time periods. Even though they have many disagreements with regard to their findings, broadly the methods of measurement and factors responsible for temporal shifts remain the same. But one of the problems raised by the scholars on productivity trends was the poor quality of data in the country and the

Table 8: Estimates of the Cobb Douglas Production Function (1988-1998) of different Engineering groups

Variable	Metal industries				Machinery Industries				Electrical Industries				Transport Industries			
	Coefficient	Standard Error	t value	P value	Coefficient	Standard Error	t value	P value	Coefficient	Standard Error	t value	P value	Coefficient	Standard Error	t value	P value
Intercept	–0.1419	0.9009	–0.15	0.88	1.356	0.4999	2.71	0.030	–0.0471	0.508	–0.09	0.929	1.023	3.15	0.33	0.75
X_1	1.1439	0.0965	11.84	6.92E-09	0.671	0.190	3.52	0.010	0.5902	0.088	6.68	0.001	–0.089	0.075	–1.18	0.28
X_2	–0.1941	0.0699	–2.77	0.02	0.041	0.058	0.72	0.497	0.3561	0.075	4.76	0.002	1.06	0.110	9.65	2.7E–05
X_3	0.0661	0.1668	0.39	0.70	0.129	0.189	0.69	0.513	0.1442	0.053	2.73	0.029	–0.002	0.425	–0.01	0.99
	R^2 = 0.995 F = 1.476				R^2 = 0.967 F = 68.98				R^2 = 0.976 F = 96.68				R^2 = 0.97 F = 78.23			

Source: Computed from Sample Data

X_1 = Raw material X_2 = Labour X_3 = Capital

Table 9: Estimates of the Trans log Production Function (1988- 1998) of different Engineering groups

Variable	Metal product group			Machinery group			Electrical group			Transport group		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Intercept	3.995	2.797	1.428	–12.836	23.517	–0.546	3.675	1.229	7.053	2.459	0.398	6.186
X_1	0.258	0.291	0.884	0.447	0.526	0.848	0.295	0.102	2.893	0.722	0.049	14.47
X_2	0.564	0.289	1.951	0.0290	0.881	0.033	0.011	0.650	0.164	0.027	0.039	0.634
X_3	–0.021	0.229	–0.094	2.148	2.007	1.070	0.154	0.059	2.618	0.149	0.033	4.502
X_4	–2.9E-13	4.43E-13	0.654	7.38E-14	1.24E-13	0.595	3.08E-14	1.92E-14	1.601	–1.3E-14	1.52E-14	–0.85
X_5	–3E-12	4.22E-12	–0.7098	1.19E-12	1.16E-12	1.029	1.42E-13	5.55E-13	0.256	9.84E-13	2.28E-12	0.43
X_6	2.14E-10	3.12E-10	0.687	–1.1E-09	1.94E-09	–0.553	–1E-13	1.79E-11	–0.006	–1.1E-11	9.71E-12	–1.09
X_7	1.96E-12	2.5E-12	0.774	1.3E-12	1.26E-12	–1.037	8.39E-15	2.22E-13	0.038	–2.3E-13	2.98E-13	–0.77
X_8	–1.6E-11	3E-11	–0.5197	–2.3E-12	3.04E-11	–0.075	–6.9E-13	7.83E-13	–0.879	1.14E-12	7.58E- 13	1.51
X_9	2.08E-10	4.2E-10	0.495	6.44E-11	633E-11	1.019	3.96E-12	5.3E-11	0.169	–1.7E-12	1.06E-12	–1.597

Source: Computed from Sample Data

X_1 = Raw Material X_2 = Labour X_3 = Capital

consequent inaccuracies in the value of coefficients. The productivity trends worked out in this study are also not free from these problems. Hence the methodology was limited to the conventional Cobb-Douglas production function and Translog production function.

Cobb-Douglas type production function was estimated for the study groups, metal product, machinery, electrical transport group to estimate the input behaviour using the following function,

$$Q = A X_1^{\alpha} X_2^{\beta} X_3^{\kappa} u$$

$$\ln Q = \ln A + \alpha \ln X_1 + \beta \ln X_2 + \kappa \ln X_3 + \ln u$$

Where, Q = Output

X_1 = Raw material

X_2 = Labour

X_3 = Capital

The results are available for the four engineering groups in Table 8. From the table it is seen that in the case of metal product group, the most significant input is raw material. The coefficient for labour cost was found to be insignificant but negative, may be due to the disproportionate growth in labour cost. The inferences based

The electrical group plays a significant role in Kerala's industrial scenario compared to other groups because of its strategic importance both as a final and intermediary product.

on the samples mentioned here are almost consistent with the results based on ASI study for the entire state also. (α = 1.19, t = 2.45). In the ASI approach also, the labour cost coefficient is found to be negative. To validate further, the coefficients were compared with the neighbouring states, Tamilnadu, (α = 1.58, t = 7.29) Karnataka, (α = 1.22, t = 5.75) Andhra Pradesh (α = 1.26, t = 9.99) and at the national level (α = 1.30), t = 2.84) and the results very much agreed with the behaviour in other states. Hence we may infer that the production of metal group very much depends on the raw material. This was established earlier also.

In the case of machinery group also, raw material continued its supremacy over the other chosen inputs. For the sample study, raw material was the only significant factor contributing towards output. The state level estimates also supported this argument (α = 1.34, t = 3.41) Further, at the state level, the labour cost coefficient takes a very high value (β = 3.85) but compared with the t value, the significance is marginal. This is the trend in other states also. It is also noted that in certain cases, the labour cost coefficient becomes negative. This may be due to disproportionate labour cost or data inconsistency.

The electrical group plays a significant role in Kerala's industrial scenario compared to other groups because of its strategic importance both as a final and intermediary product. The input coefficients, raw material, labour and capital were found to be statistically significant in the analysis, the major contributor being raw material closely followed by labour. Even though the coefficient for capital is also statistically significant, its relative role is minimum because of the nature of the industry. It was consistent with the results based on ASI study for the entire state (α = 0.64, t = 3.45, β = 6.6, t = 2.8, κ = 0.60, t = 3.61) This sample behaviour was also compared with the all India performance and the behaviour of the neighbouring states and found that the results are consistent in majority of the situations. Hence we may infer that raw material and labour cost are the two significant factors contributing towards output in the electrical group.

Lastly, in the case of transport group, labour cost was found to be more relevant compared to other two inputs because only labour cost recorded statistically significant value. It is also observed that raw material had a negative coefficient for this group, but fortunately it is statistically insignificant. For the results on the ASI based study at the state level (β = 4.44, t = 3.97) and other states also, labour is a significant input.

Considering the entire picture for the samples and comparing it with the performance in other states and also at the national level, one can easily identify raw material as the most significant input influencing output. This was established in the earlier discussions also. But when drawing an inference like this, it has to be remembered that these computations are based on sample data that too suffering from different deficiencies referred earlier. Thus it is quite appropriate to seek reassurance adopting another approach. To serve this purpose, an attempt was made to fit a Translog production function also to the sample data.

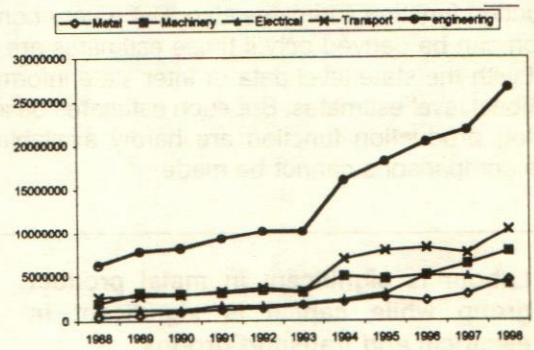

Fig. 1. Value of output of different Engineering groups

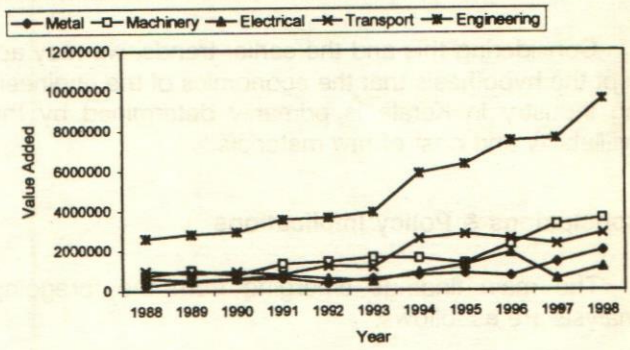

Fig. 2. Value added of different engineering groups

The interesting property of Transcendental production function is that it provides a second order approximation to an arbitrary twice continuously differentiable function and also accommodates varying elasticity of substitution. Translog production function takes the following form:

$$\ln Y = \alpha_k \ln (K) + \alpha_L \ln (L) + \alpha_T (T) + \tfrac{1}{2}\beta_{KK} \ln (K)^2 + \beta_{KL} (\ln K)(\ln L) + \tfrac{1}{2}\beta_{LL} \ln (L)^2 + \beta_{KT} (\ln K)(T) + \beta_{LT} (\ln L)(T) + \tfrac{1}{2}\beta_{TT} (T)^2$$

By imposing constant returns to scale, perfect competitive equilibrium, linear homogeneity in prices and Hicks-neutral technical progress and rearranging, the above equation yields,

$$At = \ln (Yt/Yt-1) - Sl \ln (Lt/\ln Lt-1) - Sk \ln (Kt/Kt-1)$$

where, Sl and Sk are income shares of labour and capi-

tal respectively. (Jorgenson and Griliches (1967))

The estimated translog function for the different engineering groups is available from Table 9. From the analysis it is seen that labour is significant in metal product group while capital is significant in electrical and transport groups. The supremacy of raw material as an input is evident in the electrical and transport groups. Compared with the Cobb-Douglas approach, the relative role played by raw material is evident in Translog production function estimates also. But a very concrete opinion can be derived only if these estimates are compared with the state level data or inter state information or national level estimates. But such estimates based on Translog production function are hardly available and hence comparisons cannot be made.

Labour is significant in metal product group while capital is significant in electrical and transport groups.

Considering this and the earlier trends, we may accept the hypothesis that the economics of the engineering industry in Kerala is primarily determined by the availability and cost of raw materials.

Conclusions & Policy Implications

The main findings emerging from the foregoing analysis are as follows:

- The analysis clearly spells out the role of raw material in deciding the economics of the industry.
- The comparison of the structural ratios of different engineering groups judged the transport group as a better performing group compared to others.
- The low coefficient value of capital as a result of stock accumulation and low share of fixed capital in the capital structure points to low amount of investment in plant and machinery thereby indicating the use of obsolete technology.
- The rise in the cost of inputs had led to a high input output ratio. This is mainly due to the increased transport cost that has to be met by all the engineering groups in the state because of locational diseconomies.
- The structural ratios indicated low input use efficiency in all the four engineering groups.
- Throughout the discussion, the detrimental role of raw material which adversely affected the economics of engineering industry was observed. The wages of the workers and fuel cost did not show positive relationship with production. Keeping in view these factors, the following policy measures may be adopted:
- Adequate and regular supply of raw material should be ensured in order to augment production. Since raw material is not available in the state, the state government can think of giving subsidy or other concession on imports so that cost of production can be curtailed.
- It is high time to modernize and update the technology of engineering units. This requires finance, will and dedication on the part of unit owners.
- A prerequisite for industrial development and total development of the state is well-developed infrastructure where engineering units are also not an exemption. Hence both public investment and private investment may be diverted towards infrastructure development. Complementarity between public investment and private investment is also important for infrastructure development.
- One of the limitations of the state government is the lack of a perspective policy in all fronts where engineering industry is also not an exemption. Considering the strategic importance of engineering industry in the state, particularly in the context of decentralization, the state government can appoint a task force for the purpose.
- Cheaper and regular energy power should be made available to the industry in view of the present energy crisis.
- Full utilization of the capacity in the units should be ensured. So far capacity utilization could not be fully harnessed due to inadequate demand for production, delay in getting raw material and irregular power supply. This has led to high cost per unit of production.

In the age of globalisation and free market regime, if the state is to emerge as a global player of significance, the flow of investment to this key industry has to be augmented to levels which are much higher than what they are at present. Liberalized policy should be aiming at the upgradation of technology, thereby improving the quality and productivity of engineering industry. R&D activities should be more intensified, which will enable the engineering units to go for updating their moulds and

designs. Computer Aided Designs will definitely help them in this direction. Measures for cost control, modernisation, upgradation, computerization etc will help in strengthening the forward and backward linkages of the engineering industry within the state. The industry must keep abreast with the rapid technological changes also.

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□

Feature

Corporate Reporting on Intangibles in India

V.K. Vasal

In recent years, intangible assets, including intellectual property rights (IPRs), have been widely acclaimed as a key resource in creating value particularly at the level of a business unit. The present paper aims at critically examining the select conceptual issues in accounting for intangible assets. The paper analyzes the corporate reporting practices on intangibles in India. There is the need for issuance of a comprehensive pronouncement on accounting for intangibles in India. The ensuing regulatory regime shall make managements more accountable for the intangible resources entrusted to them. It shall make corporate annual reports more meaningful and useful to the external users; argues the author.

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Perspective

Intangible assets represent invisible inputs or resources such as technology, patents, copyrights etc. These inputs contribute to the creation of income and wealth as desired outputs at two different levels – macro (aggregate) and micro (say, a business unit). The focus of the present research paper is on assessing the significance of and accountability for the intangible assets at the micro level, particularly for a business entity organized in the form of a corporate body.

Currently, intangible assets constitute a larger proportion of the resources that are deployed by a representative business unit for production of goods and services. This is true for industries in general and not just for technology-or knowledge-intensive industries such as pharmaceuticals, information technology, biotech and a significant chunk of the services industries. The Brookings Institute has inferred that asset base of the US manufacturing firms has shifted markedly during the past two decades or so. Whereas, physical assets (inputs) like plants, factories, and equipment represented 62 per cent of the market value of the manufacturing companies in 1982, they now represent less than 30 per cent of the value (quoted in Rivette and Kline, 2000). Obviously, intangible assets account for the rest of the market values of the manufacturing companies. In fact, transnational companies like Dell, Dow Chemical, Gillette, IBM, Lucent, Microsoft, and XEROX now consider effective management of intangible assets as crucial in ensuring profitable existence on a sustainable basis.

In India too, industry has duly acknowledged the value of intangible assets. For instance, Hindustan Lever Limited (HLL) is reported to have acquired trademarks, an intangible asset, from Lakme for an amount of Rs. 1.1 billion (HLL, 1998 Annual Report, p. 38). So far as the importance of effective management of intangible assets is concerned, the Chairman of Dr. Reddy's

Laboratories (DRL) has remarked the following through 1998-99 annual report of the company '... management of intellectual capital is potentially a greater source of competitive advantage than its mere possession' (p. 37). These examples illustrate the contemporary corporate behaviour in India towards effective management of their intangible assets.

For effective management of intangible assets and accountability thereon, periodic reporting on these assets is of paramount importance. This reporting is required on a regular basis both within and outside a business entity. It is widely agreed that adequate and appropriate external reporting on intangible assets through corporate annual reports (CARs) not only enables the management to discharge their stewardship function, but also permit varied external user-groups in taking informed economic decisions. How is the Indian corporate sector accounting for intangible assets through the CARs?

For effective management of intangible assets and accountability thereon, periodic reporting on these assets is of paramount importance.

The present paper aims at the following. First, it critically examines the select conceptual issues concerning accounting for intangible assets. Second, it analyzes the quality of disclosures on intangible assets through Indian CARs. For this purpose, sample companies are selected from two industries-pharmaceuticals and fast-moving-consumer-goods (FMCG). Based on the empirical findings, suitable recommendations have been made in the paper for improving the quality of external reporting through the CARs in India.

Conceptual Background

The first conceptual issue concerning accounting for intangible assets relates to the definition of the term 'assets'. The contemporary accounting literature defines an asset as 'a resource (a) controlled by an enterprise as a result of past events; and (b) from which future economic benefits are expected to flow to the enterprise' (IASC, 1998, para 7)'. To elaborate, an asset represents that part of the expenditure which has brought/brings into existence items (both tangible and intangible) that possess future economic benefits. A control on, rather than legal ownership of, future economic benefits is an important characteristic of an asset. The Generally Accepted Accounting Principles (GAAPs), have broadly classified various items constituting assets as either 'current assets' or 'non-current or long-lived assets' (Ernst and Young, 1990). Alternatively, assets are categorized as 'monetary assets', 'tangible assets' or 'intangible assets'.

The second conceptual issue relates to the definition and importance of the term intangible in 'intangible assets'. According to the Institute of Chartered Accountants of India (ICAI), an intangible asset is one 'which does not have a physical identity e.g., goodwill, patents, copyright, etc.' (ICAI, 1983). Bhattacharyya and Dearden (1996), on the other hand, have stated that intangible assets lack physical substance but possess economic value'. Read together, these two definitions produce a dilemma at a conceptual level for monetary (money, bank deposits, accounts receivables, long-term investments, and such other assets with fixed claims to money). As it is, monetary assets (both current and long-lived) lack in physical substance (an essential attribute of intangible assets) and, therefore, qualify as intangibles as per the definitions given by ICAI (1983) and Bhattacharyya and Dearden (1996). But, according to the accepted wisdom, monetary assets (both current and long-lived), though lacking in physical existence, are not intangible assets (Keiso and Weygandt, 1989). Hence, whereas lack of a physical existence is an essential condition to classify an item of assets as intangibles (as defined by ICAI, 1983; and Bhattacharyya and Dearden, 1996), it is not a sufficient criterion (Keiso and Weygandt, 1989). Further, it may be added that the contemporary accounting literature defines 'intangibles' in terms of long-lived assets only that are converted into expenses over a number of accounting periods (Anthony et al, 1995; ASC, 1997; and IASC, 1998). 'An intangible asset is an identifiable non-monetary asset without physical substance held for use in the production or supply of goods or services, for rental to others, or for administrative purposes' (IASC 1998). Thus, intangible assets now refer to (i) non-monetary assets, (ii) that have no physical existence, and (iii) that are long-lived in nature. In view of this, it is proposed that ICAI (1983) definition should be modified so that only non-monetary and long-lived items that lack in physical existence are classified as intangible assets.

The third conceptual issue relates to the scope of intangible assets. Anthony et al, (1995) have discussed accounting for intangible assets for six major categories of assets, namely (i) Goodwill; (ii) Patents, Copyrights and Franchise Rights; (iii) Leasehold improvements; (iv) Deferred Charges; (v) R&D Costs; and (vi) Software Development. Additionally, they have classified intangible assets into 'identifiable' (items that can be sold

individually like patents, licenses, and trademarks), and 'unidentifiable' (items that cannot be realized without selling the entire enterprise like reputation for quality, and customer loyalty). Anthony et al, (1995) have included both 'identifiable' and 'unidentifiable' assets within the scope of intangible assets. Thus the scope of intangible assets as given by Anthony et al, (1995) is broader than that endorsed by IASC (1998). Interestingly, Bhattacharya and Dearden (1996) appear to have taken a still broader view of intangible assets. They also have included 'fictitious assets (accumulated debit balance of the profit and loss account)' within the scope of intangibles. There is a lack of consensus in the literature on the scope of intangible assets. Therefore, Indian professional accountancy bodies like ICAI should initiate a debate on the scope of intangible assets keeping national economic environment, regulations and circumstances in view. This debate should, *inter alia*, culminate into issuance of authoritative pronouncements on the scope of intangible assets.

There is a lack of consensus in the literature on the scope of intangible assets.

The last conceptual issue relates to the intangible assets that may be partly tangible. For instance, some of the intangible assets may be contained in or on a physical substance such as a compact disk (e.g., computer software), a legal document (e.g., a patent or a license) etc. The IASC (1998) has stated clearly that while determining whether an asset that incorporates both intangible and tangible elements should be treated as a tangible or intangible asset, a judgement is required to assess as to which element (physical or intangible) is primary or more significant (para 3). Since in the case of computer software, patents, licenses etc., the intangible component is predominant and more valuable as against the physical component, these items are classified as intangible assets. It is only appropriate that this criterion is applied on a consistent basis for various other items of partly (in)tangible assets that either exist or shall potentially emerge in the new or old economy.

Some of the intangible assets may be contained in or on a physical substance such as a compact disk (e.g., computer software), a legal document (e.g., a patent or a license) etc.

Regulatory Environment

The regulatory (institutional) framework governs both the quantity and quality of information supplied through the financial accounting reports. At a relatively higher level in the regulatory framework are the statutes that provide legal environment concerning, say, accounting for intangibles. In India, two primary statutes of this general character are the Companies Act, 1956 and the Income-Tax Act, 1961. The Companies Act (Puliani and Puliani, 2000) primarily governs the preparation and presentation of external financial statements that appear as an integral part of the Indian corporate annual reports. Schedule VI of the Act has prescribed the form and content of two primary financial statements, namely a balance sheet and a profit and loss account. The Schedule, *inter alia,* has mandated the minimum disclosures in the horizontal form of a balance sheet. The Schedule requires that 'Assets' should be classified into the following four major heads in the balance sheet. These are (i) Fixed Assets, (ii) Investments, (iii) Current Assets, Loans and Advances, and (iv) Miscellaneous Expenditure (to the extent not written off). Notably, the Schedule has specified no unique account-head for exclusively summarizing information on intangible assets. A further perusal of the format has revealed the following. First, the Schedule has specified items constituting tangible as well as intangible long-lived assets under the 'fixed assets' head. On intangibles, distinct reporting, as far as possible, is required on expenditures pertaining to (a) goodwill, (b) leasehold, and (c) patents, trade marks and designs, sub-heads, Also, the Schedule mandates that for each of the sub-heads 'the original cost... and the total depreciation written off... up to the end of the year should be stated'. Second, the Schedule has mandated that 'Miscellaneous Expenditure' head should distinctly disclose, among other things, information on such intangible items as (a) preliminary expenses, (b) expenses including commission or brokerage on underwriting or subscription of shares or debentures, (c) discount allowed on the issue of shares or debentures, (d) development expenditure not adjusted, (e) other items like debit balance of profit and loss account carried forward after deduction of the uncommitted reserves. To sum, Companies Act in India has mandated disclosures on intangible items within two of the four designated heads of assets. These are 'fixed assets' and 'Miscellaneous Expenditure'. Whereas, the former includes both tangible and intangible items, the latter is devoted exclusively to the intangible items. Given the foregoing, it is proposed here that the Companies Act in India should be so amended that summarization and disclosure of information on intangible assets is not combined with that on tangible assets. And, ideally, all the intangible items should be disclosed and aggregated under a single asset head.

Companies Act in India should be so amended that summarization and disclosure of information on intangible assets is not combined with that on tangible assets.

Since fiscal 1998-99, while computing taxable income of businesses, the Income-Tax Act in India has mandated usage of the declining balance method for estimating the annual depreciation/amortization charge for intangible assets. The Act has prescribed rates of depreciation for seven blocks of intangible assets. These are (i) know-how, (ii) patents, (iii) copyrights, (iv) trademarks, (v) licenses, (vi) franchises, and (vii) any other business or commercial rights of similar nature (see Singhania et al, 2001). This proviso in the Income-Tax Act implies that items falling within the aforesaid seven blocks of intangible assets (essentially rights) now rank the same as items constituting tangible assets. However, it is argued that this amendment in the Act is only a half-hearted attempt in accomplishing the eventual goal of similar accounting treatment for both intangible and tangible assets.

At a comparatively lower level in the regulatory framework are the accountancy bodies, both in public- and private-sectors, that issue pronouncements relevant to the external financial reports (see Foster, 1986). In recent past, to illustrate, the Accounting Standards Board (ASB) in the UK has issued Financial Reporting Standard (FRS) 10 on 'Goodwill and Intangible Assets' (ASB, 1997). Likewise, the International Accounting Standard (IAS) 38 on 'Intangible Assets' (IASC, 1998). IAS-38 (1998) has, *inter alia,* superseded the IAS on the R&D Costs and has enunciated principles concerning accounting for R&D within itself. That is, expenditure on R&D is considered by the IAS-38 (1998) as a particular case of expenditures incurred on intangible assets. In India, Accounting Standards Board (ASB) of the Institute of Chartered Accountants of India (ICAI) is a body that is discharging responsibilities comparable to those of the ASB in the UK. ASB has issued 23 Accounting Standards (AS) till now. Out of these pronouncements, AS-8 (1985) deals with 'Accounting for Research and Development (R&D) Costs', an important item of intangible assets. AS-10 (1985) and AS-14 (1994) too discuss select aspects of accounting for some intangible assets, but in the passing. Obviously, Indian regulatory environment needs to be strengthened and streamlined further to match the worldwide developments discussed above.

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Findings & Discussion

In this section, some preliminary results on the corporate disclosures on intangible assets have been analysed and discussed for the sample year 1998-99. Specifically, the analysis has been performed on the annual reports of sample companies closing their annual accounts in 1998-99, that is on a between April 1, 1998 and March 31, 1999. For the purpose of analysis, a sample of fifteen companies has been taken from two industries – six companies from pharmaceuticals industry and nine companies from FMCG industry. Three pharmaceuticals and four FMCG sample companies, are members of the 'Sector Top-10' club of the most valued companies, as measured in terms of market capitalization (Business Today, 2000). These companies (with Top-10 rank in the respective sector indicated in brackets) are Ranbaxy (1), Cipla (2), and Dr. Reddy's Laboratories (5) in the pharmaceuticals industry, and Hindustan Lever (1), Nestle (3), Colgate Palmolive (5), and Dabur (7) in the FMCG industry.

Prior to examining the disclosures on intangible assets in detail, Table 1 and 2 have summarized total assets vis-a-vis intangible assets of the sample companies in, respectively, pharmaceuticals and FMCG industries. For the pharmaceuticals industry, Table 1 shows that size of total assets for the sample companies has varied between Rs. 883.0 millions (Parke-Davis) and Rs. 18.3 billions (Ranbaxy). And, intangible assets as a percentage of total assets vary in the range of 1.2 per cent (Cipla) and 24.6 per cent (Parke-Davis) in the industry. For the FMCG industry, Table 2 shows that size of total assets varies between Rs. 360.4 millions (Milkfood) and Rs. 19.8 billions (Hindustan Lever). And, intangible assets as a percentage of total assets vary in the range of 0.0 per cent (Nestle) and 25.6 (Colgate Palmolive). It is, thus, inferred that the size of total assets and relative importance of intangibles varies widely across the sample firms in both the industries. Interestingly, Table 2 has also shown that three sample companies in the FMCG industry – Hindustan Lever, Milkfood, and Nestle – have not shown any item/amount under the 'Miscellaneous Expenditure' head on their respective balance sheets.

For a detailed analysis, it may be noted here that accounting for intangible assets has been historically

Table 1: Total Assets versus Intangible Assets (1998-99)

Name of Pharmaceutical Company	Total Assets Rs. million	Fixed (Intangible) Assets Rs. million	Miscellaneous Expenditure (Intangible) Rs. million	Total Intangible Assets as a percentage of Total Assets (%)
Cipla Ltd. (CL)	4954.6	54.5	3.6	1.2
Dr. Reddy's Laboratories Ltd. (DRL)	4948.6	22.9	430.5	9.2
Lupin Laboratories Ltd. (LL)	8001.6	162.0	285.8	5.6
Parke-Davis (India) Ltd. (PD)	883.0	0.0	218.1	24.7
Ranbaxy Laboratories Ltd. (RL)	18257.7	44.7	476.9*	2.9
Rhone-Poulenc (India) Ltd. (Rp)	915.6	8.1	30.0	4.2

*(for a period of 9 months ending December 1998)

Table 2: Total Assets versus Intangible Assets (1998-99)

Name of FMCG Company	Total Assets Rs. million	Fixed (Intangible) Assets Rs. million	Miscellaneous Expenditure (Intangible) Rs. million	Total Intangible Assets as a percentage of Total Assets (%)
Colgate Palmolive (India) Ltd. (CP)	2988.7	733.5	31.5	25.6
Dabur India Ltd. (DL)	5564.4	83.0	98.4	3.3
Godrej Soaps Ltd. (GS)	7480.7	15.6	92.9	1.5
Herbertsons Ltd. (HL)	710.6	2.5	10.6	1.8
Hindustan Lever Ltd.* (HLL)	19773.4	1131.3	0.0	5.7
Milkfood Ltd. (ML)	360.4	1.7	0.0	0.5
Mohan Meakin Ltd. (MM)	667.7	2.1	21.9	3.6
Nestle India Ltd.* (NL)	5303.4	0.0	0.0	0.0
United Breweries Ltd. (UB)	7434.8	47.1	69.0	1.6

*(for accounting period ending December 1998)

prescribed by the professional accountancy bodies in countries such as the US and the UK, besides the IASC, by issuing, at least, two different accounting pronouncements. These pronouncements have been on (a) Accounting for Research and Development (R&D) Costs, and (b) Accounting for other Intangible Assets (including Goodwill). In India, since Companies Act has prescribed some disclosures on R&D Costs since late 1980s, and as an accounting standard (AS-8) also has been in existence on this subject since mid 1980s, accounting for R&D Costs by Indian companies have been analyzed separately.

Accounting for Research and Development (R&D) Costs

To begin with, in order to assess the relative focus laid by a sample firm on its R&D activities, R&D expenditure of each sample company has been examined for the year 1998-99. Table 3 and Table 4, respectively, have summarized relevant accounting numbers in this regard for pharmaceuticals and FMCG industries. For the pharmaceuticals industry, Table 3 shows that R&D expenditure of the sample companies is in the range of Rs. 9 millions (Parke-Davis) and Rs. 456 millions (Ranbaxy) during the sample year. As a percentage to turnover, the size of the ratio is in the range of 0.1 per cent (Rhone-Poulenc) and 4 per cent (Ranbaxy). Thus, R&D expenditure, both in absolute and relative terms, has varied widely across the sample firms. Also, it is found from the Table that Ranbaxy is the lead-spender on R&D both in absolute and relative terms.

Table 3: Expenditure on Research and Development (R&D) (1998-99)

Name of Pharmaceutical Company	Capital Expenditure Rs. million	Recurring Expenditure Rs. million	Total Expenditure Rs. million	Total R&D Expenditure as a percentage of turnover (Net)
Cipla Ltd.	9.7	230.5	240.2	3.9
Dr. Reddy's Laboratories Ltd.	59.9	34.1	94.1	2.2
Lupin Laboratories Ltd.	98.1	108.4	206.5	3.2
Parke-Davis (India) Ltd.	0.7	8.7	9.3	0.5
Ranbaxy Laboratories Ltd.	117.9	338.5	456.4*	4.0
Rhone-Poulenc (India) Ltd.	22.5	7.2	29.7	0.1

*(for a period of 9 months ending December 1998)

On the other hand, for the FMCG industry, Table 4 shows that R&D expenditure of the sample companies is in the range of Rs. Zero (for five companies, namely Herbertsons, Milkfood, Mohan Meakin, Nestle, and United Breweries) and Rs. 373 millions (Hindustan Lever) during the sample year. As a percentage to turn-

over, the size of the ratio is in the range of 0.0 per cent (for aforesaid five sample companies) and 3.5 per cent (Colgate-Palmolive). Thus, like the pharmaceuticals industry, R&D expenditure has varied widely across the sample firms, both in absolute and relative terms. An interesting finding here is that, amongst the sample firms, whereas Hindustan Lever is the lead spender on R&D in absolute terms, Colgate-Palmolive is the sample leader in relative terms.

Table 4: Expenditure on Research and Development (R&D) (1998-99)

Name of FMCG Company	Capital Expenditure Rs. million	Recurring Expenditure Rs. million	Total Expenditure Rs. million	Total R&D Expenditure as a percentage of turnover (Net)
Colgate Palmolive (India) Ltd.	309.1	35.5	344.6	3.5
Dabur India Ltd.	14.5	57.1	71.6	0.8
Godrej Soaps Ltd.	0.0	15.3	15.3	0.2
Herbertsons Ltd.	0.0	0.0	0.0	0.0
Hindustan Lever Ltd.*	53.2	319.9	373.1	0.4
Milkfood Ltd.	0.0	0.0	0.0	0.0
Mohan Meakin Ltd.	0.0	0.0	0.0	0.0
Nestle India Ltd.*	0.0	0.0	0.0	0.0
United Breweries Ltd.	0.0	0.0	0.0	0.0

*(for accounting period ending December 1998)

With regard to accounting practices on measurement and disclosures of the elements of R&D, an analysis of the corporate annual reports has shown the following for the sample companies. (i) Since it is mandated through the Companies Act, every sample company, in both pharmaceuticals and FMCG industries, is reporting on its R&D efforts and costs through an Annexure to the Directors' Report. (ii) An examination of the 'Statement of (Significant) Accounting Policies' has shown the following. For the pharmaceuticals industry, all the sample companies, are charging their respective 'revenue expenditure on R&D' against the profits for the relevant year. Although, LL has also stated that it is deferring a part of its R&D expenditure of revenue nature. On the other hand, for the FMCG industry, seven of the nine sample companies are charging their respective 'revenue expenditure on R&D' against the profits for the relevant year. And, two sample companies – ML and UB have not stated explicitly their accounting policies on R&D costs. One possible reason for this omission could be the non-significant magnitude of the R&D expenditure in the operations of the said two companies. (iii) All sample companies in the pharmaceuticals industry have explicit accounting policies of showing capital expenditure on R&D as an addition to the fixed assets. On the other hand, in the FMCG industry, the following is noted for the seven sample companies with explicitly stated accounting policies on R&D expenditure. Only five (of the seven) companies – CP, GS, HLL, MM and NL – have declared categorically that they are incorporating capital expenditure on R&D as an addition to the fixed assets. And the other two companies – DL and HL – have not described their accounting treatment of R&D Costs of capital nature through their respective Statements of Accounting Policies. (iv) So far as accounting policies adopted by the sample firms in valuation of their fixed assets (a head wherein capital expenditure on R&D is included as a constituent part for majority of the sample firms, are concerned, the following are the inferences of the present study. In the pharmaceuticals industry, five (of six) sample companies – CI, DRL, LL, RL, and RP – have calculated depreciation on their fixed assets as per the rates specified in the Companies Act. The sixth company-PD – has, on the other hand, specified the specific rates of depreciation used by her through her Notes of Accounts. As far as usage of depreciation method(s) is concerned, four sample companies-CI, DRL, LL, and PD – have used only straight-line method (SLM) of depreciation. And, the other two-RL and RP – have employed both the straight-line method (SLM) and the written-down value (WDV) method. On the whole, all the sample companies in the pharmaceutical industry are using, at least, SLM of depreciation for valuation of their fixed assets. For the FMCG industry, it is found that each of the five (of nine) sample companies-CP, GS, HLL, MM and NL – that has explicitly included capital expenditure on R&D to its fixed assets is calculating depreciation on its fixed assets as per the rates specified in the Companies Act. So far as, choice of depreciation method(s) is concerned, four companies-CP, GS, HLL and NL – have used straight-line method (SLM) of depreciation. And, one company-MM – has employed both the straight-line method (SLM) and the written-down value (WDV) method. Thus, it is found that, like pharmaceuticals industry, all the sample companies in the FMCG sector are using, at least, SLM of depreciation for valuation of their fixed assets.

Accounting for other Intangibles (including Goodwill)

Tables 5 and 6 have summarized the empirical results on the disclosures for seven taxonomies/ categories of other intangible assets for pharmaceuticals and FMCG industries, respectively. Table 6 shows that two sample companies-ML and NL – have not reported on any of the other intangible assets in the

Table 5: Disclosures on Intangible Assets (1998-99) (other than Leased Assets)

Name of Pharmaceutical Company	Intangibles						
	Goodwill	Patents Trademarks And Designs	Marketing and Technical Knowhow (Fees)	Preliminary Expenses	Capital Issue Expenses	Management/ Marketing/ Product Dev. Expenditure	Deferred Revenue Expenditure
Cipla Ltd.	No	No	No	No	Yes	No	No
Dr. Reddy's Laboratories Ltd.	No	Yes	No	No	No	Yes	No
Lupin Laboratories Ltd.	No	No	Yes	Yes	Yes	No	Yes
Parke Davis (India) Ltd.	No	No	No	No	No	No	Yes
Ranbaxy Laboratories Ltd.*	No	No	No	No	No	Yes	Yes
Rhone Poulenc (India) Ltd.	Yes	Yes	Yes	No	No	No	Yes

* (for a period of 9 months ending December 1998)

Table 6: Disclosures on Intangible Assets (1998-99) (other than Leased Assets)

Name of FMCG Company	Intangibles						
	Goodwill	Patents Trademarks And Designs	Marketing and Technical Knowhow (Fees)	Preliminary Expenses	Capital Issue Expenses	Management/ Marketing/ Product Dev. Expenditure	Deferred Revenue Expenditure
Colgate Palmolive (India) Ltd.	Yes	Yes	Yes	No	No	No	Yes
Dabur India Ltd.	No	No	Yes	No	Yes	Yes	No
Godrej Soaps Ltd.	No	No	No	Yes	Yes	No	Yes
Herbertsons Ltd.	No	Yes	Yes	No	Yes	No	Yes
Hindustan Lever Ltd.*	Yes	Yes	No	No	No	No	No
Milkfood Ltd.	No	No	No	No	No	No	No
Mohan Meakin Ltd.	No	Yes	No	No	Yes	No	Yes
Nestle India Ltd.*	No	No	No	No	No	No	No
United Breweries Ltd.	Yes	Yes	No	No	Yes	Yes	Yes

* (for accounting period ending December 1998)

FMCG industry. A category-wise detailed analysis of the empirical results for the rest of the sample companies is as follows. Notably, for interpreting the quality of corporate reporting, empirical findings have been benchmarked against the requirements of the Companies Act, 1956 in India. Accounting policies of the sample companies in amortizing the intangible items have also been analyzed.

(i) *Goodwill:* Table 5 shows that, in the pharmaceuticals industry, only RP has shown goodwill through the 'Fixed Assets' head of her balance sheet. However, the company has combined its reporting on goodwill with that on trademarks. And, the company is showing combined reporting on two different types of intangibles, goodwill and the rights, as a single accounting number. Combining together of goodwill and trademarks is not only at variance with the distinct reporting intended on these two items under the Companies Act, but is also theoretically unsound. It is, therefore, suggested that RP should disclose these two intangible assets independently on its balance sheet. Table 6, on the other hand, shows that three sample companies-CP, HLL and UB – in the FMCG industry have disclosed goodwill. Interestingly, while CP and UB have treated goodwill as an asset (an unexpired cost) and shown it through the 'Fixed Assets' head of their respective balance sheets, HLL has fully written-off the amount of goodwill to its profit and loss account, very much like an expense item. Further, it is found that whereas UB has disclosed goodwill as a distinct item, CP has combined its reporting on goodwill with that on trademarks. That is, CP has combined two different types of intangibles, goodwill and the rights, into a single accounting number, like RP in the

pharmaceuticals industry. This reporting practice, of course, is not only at variance with the distinct reporting intended on these two items under the Companies Act, but is also theoretically unsound. It is, therefore, recommended that CP also should take steps to separately show goodwill and rights on her balance sheet.

Colgate Palmolive has combined two different types of intangibles, goodwill and the rights, into a single accounting number.

For periodic write-off of goodwill, an examination of the annual reports has shown the following. In the pharmaceuticals industry, RP has an explicit accounting policy to amortize the amount paid for acquisition of goodwill and trademarks over a period of 14 years. In the FMCG industry, on the other hand, it is found that CP is amortizing her goodwill on a straight-line basis over a period of 40 years. HLL, as explained in preceding paragraph, is amortizing full amount of the goodwill in the year in which it is incurred. And, it is found that UB has not stated explicitly her accounting policy for amortizing goodwill. However, an analysis of her balance sheet has revealed that the amount of goodwill shown by the company in both the current and the previous years is the same. This implies UB is treating goodwill as an asset with an infinite life and, hence, is not been writing off any portion of it during the current year. On the whole, it is evident that amortization period is ranging from a single year to an infinite period for the sample companies. Surely, this difference in the amortization policies introduces material distortions in the inter-firm and inter-industry comparisons of accounting numbers.

(ii) *Patents, Trademarks, and Designs (Rights):* Table 5 shows that, in the pharmaceuticals industry, DRL has disclosed patents and trademarks (two different kinds of rights) as a single item under the 'Fixed Assets' head. And, RP is disclosing two different types of intangibles, goodwill and the rights, as a single accounting number under the 'Fixed Assets' head. Evidently, whereas DRL has combined reporting on two intangible assets both of which are in the form of rights and, therefore, in conformity with the intent of the Companies Act, the combining of rights with goodwill by RP is not considered in agreement with the intent of the Companies Act. Thus, reporting by RP is theoretically unsound and needs to be remedied. Table 6, on the other hand, shows that five sample companies – CP, HL, HLL, MM, and UB – have disclosed intangible assets in the form of rights through their respective balance sheets, in the FMCG industry. It is found that CP has reported on copyrights, designs and trademarks. HL has reported on trade licenses. HLL and MM have reported for the value of 'trademarks'. And, UB has reported on licenses and rights. Further, it is discovered that while CP, HLL, MM and UB have disclosed their respective intangible assets through the "Fixed Assets' head, the HL has (inappropriately) reported hers through the 'Miscellaneous Expenditure' head, of the balance sheet. Additionally, it is seen (as already discussed) that CP has combined her reporting on two different types of intangibles, goodwill and rights, into a single accounting number which is theoretically unsound, besides being a practice which is in disagreement with the intent of the Companies Act. Thus, for the FMCG industry, the foregoing has shown that disclosures on rights by all sample companies except two, CP and HL, are broadly in agreement with the prescriptions of the Companies Act. And it is, therefore, in the fitness of things that CP and HL improve their annual reporting on rights as intangible assets by, respectively, appropriate disaggregation and proper placement of them in their respective balance sheets.

For periodic amortization of rights as intangible assets, an examination of the annual reports has shown the following. In the pharmaceuticals industry, DRL is amortizing rights just like any other item of fixed assets by using SLM and at rates as specified in the Companies Act. And, RP is following an explicit accounting policy to amortize trademarks (and goodwill) over a period of 14 years since their acquisition. For the FMCG industry, on the other hand, it is found that, by using SLM, CP is amortizing trademarks, like goodwill, over a period of 40 years; and 'copyrights and designs' over a period of 14 years. HL is amortizing trade licenses over a period of 6 years, apparently using SLM. HLL is amortizing trademarks over a period of 4 years, though no method of amortization is mentioned explicitly nor can it be deduced from the accounting numbers published by the company. Interestingly, an analysis of the 'Fixed Assets' of MM and UB has shown that the amounts of, respectively, trademarks, and licenses and rights, shown by them in both the current and the previous years are the same. This implies that MM and UB are treating their intangible assets in the form of rights as possessing infinite lives and, hence, are not been writing off any portion of them during the current year. Interestingly, UB is also considering goodwill as an eternal asset. To sum, it is observed that corporate policies on rights as intangible assets differ widely across the sample firms both in terms of their nature and amortization. And, with the useful life of trademarks, for instance, ranging from 4 (HLL) to infinite (MM) number of years in the FMCG industry, material distortions in the inter- firm and inter-industry comparisons of the accounting numbers are bound to occur.

(iii) *Marketing and Technical Know-how (Fees):* Table 5 shows that two companies—LL and RP—are reporting on these intangible items in the pharmaceuticals industry. Whereas LL has reported 'Technical Know-how' as an item under the 'Fixed Assets' head, RP has disclosed 'Marketing and Technical Know-how Fees' through the 'Miscellaneous Expenditure' head in the balance sheet. Table 6, on the other hand, has shown that three companies-CP, DL, and HL—are disclosing technical know-how fees or an item of similar nature in the FMCG industry. While CP has disclosed Technical Know-how, DL has disclosed Technical Know-how Fees, and HL has disclosed Fees for Technical Expertise. Further, it is found that whereas CP has made disclosures under the 'Fixed Assets' head, DL and HL have reported on this intangible asset through 'Miscellaneous Expenditure' head. Thus, sample companies in both the industries have reported on this intangible asset either through 'Fixed Assets' head or through 'Miscellaneous Expenditure' head. *Prima facie*, disclosures under both the said heads seem justified in the Companies Act.

A further analysis into the annual reports has shown the following for the pharmaceuticals industry. LL, implicitly, is amortizing its process related technical know-how from the date of commissioning of the relevant projects by using SLM and at rates as specified in the Companies Act. And RP has an explicit accounting policy to amortize acquisition of marketing and technical know-how over a period of 60 months from the month of their acquisition. In the FMCG industry, on the other hand, it is found that CP has amortized this intangible asset during the sample year at a rate of over 5 per cent. However, the company has not reported, explicitly or implicitly, on the method or rate/period of amortization in its annual report. This is viewed as a serious deficiency in the reporting behavior, particularly owing to the fact that the company has explicitly stated her accounting policies on amortization of intangible assets like goodwill/trademarks, and copyrights & designs. DL has an explicit accounting policy to amortize technical know-how fees paid to collaborators over a period of 6 years. To sum, it is inferred that non-disclosure of amortization policy and/or elements thereof by the sample firms on Marketing and Technical know-how Fees bears adversely upon the cross-sectional comparison and interpretation of accounting numbers, both inter-firm and inter-industry.

(iv) *Preliminary expenses:* In India, the Companies Act has mandated reporting on preliminary expenses as the first sub-head under the 'Miscellaneous Expenditure' head in the balance sheet. Research findings summarized in Table 5 have shown that, for the pharmaceutical industry, only one company-LL—has reported on preliminary expenses under the 'Miscellaneous Expenditure' head. And, Table 6 has shown that in the FMCG industry too, like pharmaceuticals industry, only one Company-GS—has reported on preliminary expenses under the 'Miscellaneous Expenditure' head. The reporting practice of both LL and GS are, of course, in conformity with the intent of the Companies Act.

A scrutiny of annual reports has revealed that both the sample companies, LL in the pharmaceuticals industry and GS in the FMCG industry, are amortizing their respective preliminary expenses against the share premium account. It is, however, found that whereas LL is amortizing this intangible item over a period of 10 years (though no method is explicitly stated by the company), GS has disclosed neither the method nor the rate/period used for amortization. It is suggested that the sample companies should correct these inadequacies in their reporting behavior forthwith to improve usefulness of their respective annual reports.

(v) *Capital issue expenses:* Capital issue expenses relate to two major sources of finance, equity and debt. In India, Companies Act requires reporting on the capital issue expenses like commission, brokerage, discount etc. under the 'Miscellaneous Expenditure' head. Table 5 shows that two companies-CI and LL—are disclosing this item in the pharmaceuticals industry. While CI has disclosed only share issue expenses, LL is disclosing two items of the nature of capital issue expenses—public issue expenses, and up-front fees on loans. Further, it is found that both these companies have disclosed these items through the 'Miscellaneous Expenditure' head, as prescribed by the Companies Act. Table 6, on the other hand, has shown that five sample companies-DL, GS, HL, MM, and UB—are disclosing capital issue expenses in the FMCG industry. Further, it is observed that two companies-DL and GS—are disclosing only share issue expenses, two companies-HL and MM—are reporting on only debenture issue expenses, and one company-UB—is disclosing both share-and debenture-issue expenses. All the companies are, however, found disclosing these expenses through the 'Miscellaneous Expenditure' head, an accounting practice that is in consonance with the prescriptions of the Companies Act.

For the pharmaceuticals industry, an examination of

In India, Companies Act requires reporting on capital issue expenses like commission, brokerage, discount under the 'Miscellaneous Expenditure' head.

annual reports shows the following. CI has not specified its amortization policy for share issue expenses. This, undoubtedly, impairs the quality of accounting numbers reported by the company. And, LL is found explicitly adjusting its capital issue expenses over a period of 5 years to the share premium account. In the FMCG industry, on the other hand, the following is inferred for the three companies reporting on the share issue expenses. DL and UB are explicitly amortizing these expenses using SLM over a period of 10 years. And, GS is adjusting these expenses against the share premium account, like LL in the pharmaceuticals industry. Though, unlike LL, it is not found explicitly declaring the amortization period. It is worth stating here that GS has changed its amortization policy only during the sample year. Heretofore, the company was amortizing these expenses by a charge to the profit and loss account. This change in the accounting policy during the sample year, incidentally, has reduced the losses of GS for 1998-99 by an amount of Rs. 8.88 millions. Additionally, the following is inferred for the three companies reporting on debenture issue expenses in the FMCG industry. HL and UB are spreading these expenses over the lifetime of their respective debenture issues. And, MM is spreading these expenses over a period of time. The company, however, has not declared explicitly the method and rate/period used by her for amortizing debenture issue expenses. In the absence of sufficient details, it is inferred that the amortization period used by MM may/may not equal the lifetime of the debenture issue. To sum, it is found that the sample companies in both the industries not only are adopting varying practices for amortizing the capital issue expenses but also are giving inadequate disclosures on the method, rate and period of amortization. It is, therefore, suggested here that the professional accountancy bodies in India should issue suitable guidelines that shall require distinct reporting, through a supplementary schedule/notes to accounts, about the overall impact of the amortization of capital issue expenses on the financial statements of a company. This step shall, surely, help in improving the usefulness of the accounting numbers in inter-firm and inter-industry comparisons.

(vi) *Management/Marketing/Product Development Expenditure:* A scrutiny of the annual reports has revealed that companies in the pharmaceuticals industry are disclosing marketing and product development expenditures only. Table 5 shows that DRL and RL are two such sample companies. Whereas DRL is reporting on both marketing-and product-development expenditures, RL is disclosing only product development expenditure. In the FMCG industry, on the other hand, it is found that companies are disclosing management development expenditure too, besides a disclosure of market and product development expenditures. Table 6 shows that DL and UB have reported on the Management/Marketing/Product Development Expenditures in the FMCG industry. While DL is disclosing Strategic Management Consultancy Expenses, UB has disclosed expenditures on Sponsorship, and Product Launch, besides professional fees paid for Strategic Development Module. Further, it is found that all the four sample companies in the two industries are disclosing on this intangible asset through the 'Miscellaneous Expenditure' head, a disclosure practice that is in conformity with the prescriptions of the Companies Act.

Professional accountancy bodies in India should issue guidelines that require distinct reporting, about the overall impact of the amortization of capital issue expenses on the financial statements of a company.

For the pharmaceuticals industry, a scrutiny of the annual reports is as follows. DRL is amortizing both product and marketing development expenditures over the contract period. Additionally, the company has stated the following through 'Management Practices and Financial Analysis' section of her annual report. This (Miscellaneous Expenditure) represents the deferred R&D and market development expenditure incurred towards new product development, and will be written off over a period of 7 years. Thus, it is discovered that DRL has split its disclosures on the amortization of this intangible asset over more than one section of its annual report. This is an unsound accounting practice and needs to be corrected by the company henceforth. Further, it is found that RL is amortizing its product development expenditure over a period of 5 years beginning with the year of launch of product/from the date of product acquisition. Obviously, the noted differences in the amortization policies distort the inter-firm comparisons of the published accounting numbers. For the FMCG industry, on the other hand, annual reports of the sample companies have revealed the following. DL is explicitly amortizing strategic management consultancy expenses over a period of 5 years. Implicitly, the company is using SLM for the purposes of amortization. And, UB has been found amortizing its expenditures on management, marketing, and product development over a period of 3 years. Details given in the annual report are not sufficient to unravel the method used by the company for spreading this cost over time. On the whole, for this intangible asset, disclosures on the method, rate, and/or period of amortization are found either missing or dissimilar across the sample companies in both the industries. And this, undoubtedly, has

an adverse impact on the inter-firm and inter-industry comparability of accounting numbers.

(vii) *Deferred Revenue Expenditure(s) (DREs):* This is, loosely speaking, a residual category of intangible assets wherein a variety of items are included (as shall also be evident from the ensuing discussions). For the pharmaceuticals industry, Table 5 shows that four companies are reporting on their DREs. These are LL, PD, RL and RP. Company-wise details of DREs (with items disclosed by a company listed in parentheses) are – LL (voluntary retirement scheme (VRS) compensation paid to employees), PD (VRS expenditure, compensation for the termination of contractual arrangement/other arrangements), RL (non-compete agreements (NCA) expenditure) and RP (acquisition of Software systems). For the FMCG sector, on the other hand, Table 6 shows that five companies-CP, GS, HL, MM and UB – are disclosing on DREs. Company-wise details of DREs (with items disclosed by a company listed in parentheses) are as follows. CP (NCA), GS (Gratuity, VRS Compensation, and advertisement and publicity), HL (other expenses – being the aggregate of fees for trade license, technical expertise, and NCA), MM (VRS Compensation), and UB (VRS Compensation). Disclosures on DREs by all the sample companies in the FMCG industry except HL are, thus, found to be in agreement with the intent of the Companies Act. Notably, all the sample companies in the two industries are observed disclosing their DREs through the 'Miscellaneous Expenditure' head, an accounting practice that is in agreement with the requirements of the Companies Act.

Examination of the sample annual reports in the pharmaceuticals industry has revealed the following. LL is amortizing the amount of VRS compensation paid to employees using SLM over a period of 5 years. PD is amortizing VRS expenditures, and compensation for the termination of contractual arrangement/other arrangements, by charging them to the profit and loss account over a period of 60 months from accrual. RL is observed amortizing NCA expenditure over a period of 60 months. And, RP is found amortizing the expenditure on acquisition of software systems and their implementation over a period of 60 months from the month of their acquisition. For the FMCG industry, on the other hand, the following is inferred, based on an analysis of the annual reports. CP is amortizing its DREs in the form of NCA over a period during which benefits from such expenditure are derived. But, this period is not stated explicitly. GS is amortizing (i) incremental gratuity liability arising as a result of the amendment to The Payment of Gratuity Act, 1972 using SLM over a period of 10 financial years, (ii) VRS compensation over a period of 5 years using sum-of-digits method, whereby the charge is lowest in the first year and highest in the last year (that is, inverse of the usual sum-of-the-years-digits method of depreciation), and (iii) advertisement and publicity expenditure on launching of major products over a period of 12 months, beginning from the launch of product. HL is found amortizing DREs in the form of NCA over a period of 6 years (as against a flexible period chosen by CP). However, the company has not explicitly stated the method used by her. MM is explicitly amortizing VRS Compensation over a period of 4 years. Implicitly, the company is using SLM for the purposes of amortization. And, UB is found amortizing VRS compensation over a period of 60 months from the month of payment, presumably using SLM. Obviously, the aforesaid variations in the amortization policies of the two industries on a variety of intangible assets, surely, render financial statements of the companies non-comparable, both on inter-firm and inter-industry basis.

Conclusions

To sum, the empirical findings reported and analyzed have shown that, first, two sample companies in the Indian FMCG industry, Milkfood and Nestle, are reporting only on one intangible asset, namely R&D expenditure. Second, owing to the fact that all sample companies are profitable and financially healthy in the sample year, no company has disclosed information on accumulated debit balance of the profit and loss account (a fictitious asset), an intangible item/asset of controversial nature. Third, all the sample companies other than Milkfood and Nestle are reporting information on a variety of intangible items other than R&D Costs and leased assets (see Tables 5 and 6). Classification, valuation and disclosures on these other intangible assets have varied across the sample firms, both on inter-firm and inter-industry basis. There are wide variations in the observed accounting practices on many of these intangible items. Fourth, corporate accounting on intangibles in some cases is not found in consonance with the intent/requirements of the Companies Act in India. Lastly, issuance of a comprehensive pronouncement on accounting for intangibles by a professional accountancy body in India, such as the ICAI, can bring about a qualitatively improvement in the corporate accountability on intangible resources. It is reported that Accounting Standards Board (ASB) of the ICAI is currently at an advanced stage of giving shape to a pronouncement on the said subject. It is expected that this pronouncement shall be comprehensive enough to provide guidelines for all classes of intangibles. Consequently, disclosures on intangibles in the annual reports shall become more meaningful and useful to the external user-groups.

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In a lot of people's minds, making the complex clear means you just dump information on everybody. That simply adds to the confusion.

– Nigel Holmes

Feature

Education in Entrepreneurship Development

V. Murugesan & C. Thangamuthu

Several factors contribute to success in entrepreneurship endeavours. The article analyses whether technical education makes a tangible difference.

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Entrepreneurship development depends not only on economic factors but also on socio-cultural indices. Among socio-cultural aspects, education, particularly technical education, is one of the predominant factors that influences entrepreneurial development. In general, better education may be expected to yield better results in entrepreneurial performance. However, the following empirical studies have identified that technical education alone will not help one achieve success in a venture (Krishnakumar, 1998). Similarly Babu (1978) concluded that technical education did not play an important role in small scale sectors and his study revealed that nearly 75 per cent of the sample entrepreneurs had undergone only formal or non-technical education. In this connection, Vasiliades (1983) has also found that the majority of the Greek Knitting entrepreneurs had completed only primary and secondary education and very few of them were technical degree holders. Giriappa (1990) found that more than 58 per cent of the entrepreneurs had completed just matriculation education and only a few sample entrepreneurs were engineering degree holders. Further, Jayachandran et al, (1998) have found no significant relationship to exist between technically qualified entrepreneurs and their performance success. Thangamuthu and Manimekalai (1995) in their empirical work, have found that education did not necessarily enhance entrepreneurial performance. The correlation coefficient calculated exhibits negative relationship implying that highly educated entrepreneurs perform poorer than less educated ones.

All the above studies have underlined that technical education per se may not ensure entrepreneurial success. In this context, the present study seeks to analyse

Technical education per se may not ensure entrepreneurial success.

the relative entrepreneurial performance by education of the tiny, small, medium and large scale entrepreneurs in one of the industrially backward districts, Pudukkottai in Tamil Nadu, India.

Methodology

The study is based on primary data collected from the sample entrepreneurs in Pudukkottai district in Tamil Nadu. Units registered with Inspector of Factories and Districts Industries Centre have been considered for the present study. The study covered only first-generation entrepreneurs and those of the units established on or before 1992; fresh units which are yet to settle down and sick and closed units were omitted from the purview of the study. The total number of sample units is 153, of which 57 units are tiny scale, 71 units small scale and 25 units medium and large scale. The primary data pertain to a period of six years from 1991-92 to 1996-97.

Sample Profile

Majority of the entrepreneurs in tiny sector possess only general and lower level education, i.e. primary to higher secondary level. In contrast, more entrepreneurs in small scale level have higher and professional (technical qualified) education followed by the medium and large scale entrepreneurs. The organisational pattern among different groups of entrepreneurs reveal the predominance of sole proprietorship among tiny and small scale groups and of private limited units among medium and large scale group.

The sample units are divided into 14 different industrial groups. Among the groups, five groups belong to tiny scale units, 13 groups to small scale units and 10 groups to medium and large scale units. These three types are not evenly distributed in the study area. Tiny scale entrepreneurs cannot involve themselves in all industrial activities, wherein heavy investment is required. From table 1 it can be seen that majority of the tiny scale and small scale units are engaged in engineering and fabrication works. Among these, the majority of tiny scale entrepreneurs do their work independently, without support from any parent unit. In contrast, nearly 50 per cent of the small scale engineering and fabrication units get job work from the parent unit, BHEL, Tiruchirappalli. But among the medium and large scale units, only two units have undertaken ancillary job works. Most of the tiny, medium and large scale units are undertaking manufacturing activities and a few undertake job work and servicing activities. In contrast, most of the small scale units undertake manufacturing and job work. This reinforces the fact that more small scale units depend on job work (showing great dependency on parent unit) while medium and large scale units are less dependent on any parental unit.

More small scale units depend on job work while medium and large scale units are less dependent on any parental unit.

Table 1: Product Line of the Sample Units

Product line	Tiny Scale Units		Small Scale Units		Medium and Large Scale Units	
	No. of Units	Percentage	No. of Units	Percentage	No. of Units	Percentage
Fabrication (1)	22	38.59	23	32.39	2	8.00
Ferrous and non-ferrous (2)	14	24.58	15	21.12	3	12.00
Metal Products (3)	–	–	2	2.82	–	–
Plastic Products (4)	5	8.77	8	11.26	1	4.00
Chemical Products (5)	–	–	6	8.46	6	24.00
Cotton and Textile (6)	–	–	2	2.82	5	20.00
Nylon and Knitting (7)	–	–	2	2.82	1	4.00
Food Products (8)	–	–	5	7.04	2	8.00
Tobacco Products (9)	–	–	–	–	2	8.00
Wood Products (10)	5	8.77	1	1.41	–	–
Needle Products (11)	–	–	2	2.82	–	–
Paper products (12)	–	–	1	1.41	–	–
Freezing Mixture Unit (13)	–	–	1	1.41	–	–
Servicing Units (14)	11	19.29	3	4.22	3	12.00
Total	57	100.00	71	100.00	25	100.00

Source: Compiled from the primary data.

Excepting a few, all the tiny small, medium and large scale units have been established after 1980s in the district. The entrepreneurs are young, mostly in the age group of 25-45 years. Majority of tiny scale entrepreneurs belong to communities with very little business/industrial background. In other words, tiny scale entrepreneurs have come from new, non-industrial

communities. But in the case of small, medium and large scale units, industrial communities like Brahmin, Chettiyar, Naidu and Muslims are found concentrated.

Majority of the small scale, medium and large scale entrepreneurs happen to be migrants from other districts, particularly neighbouring ones, whereas the tiny entrepreneurs are generally from the native district. Previous occupation of the entrepreneurs indicates that most of the entrepreneurs in all three size groups have entered into the field only after previous experience on the same or related lines, nearly 80 per cent of them had 5 to 15 years of previous experience in the field. Majority of tiny scale entrepreneurs have been previously industrial workers; small scale entrepreneurs have worked as supervisors and the medium and large scale entrepreneurs had the experience of industrial managers. Parental educational and occupational background reveals that most of the parents are illiterate or less educated and their occupations are unrelated to industry (mostly agriculture).

Most of the entrepreneurs in all three size groups have entered into the field only after previous experience on the same or related lines.

Among the motivating factors, it is found that majority of the entrepreneurs have been motivated mainly by the urge to attain economic independence and get self-employment. Further, the main reason for starting tiny scale unit in the present location has been the availability of labourers, familiarity of the place and proximity to native place. Availability of labourers, familiarity of the place, proximity of parent industry and availability of government incentives and subsidies have been observed to be the main factors that have led to the selection of particular location among small, medium and large scale units. Education in the same and related line and previous experience have induced the entrepreneurs in selecting the particular line of production.

Education of Entrepreneurs

Majority of entrepreneurs in tiny sector possess only general and lower level education i.e. primary to higher secondary school level. This group accounts for 66.66 per cent. Only 16.80 per cent of tiny scale entrepreneurs have some technical education. In contrast, more entrepreneurs in small scale units have higher and professional (technically qualified) education which comes to around 50 per cent. Similarly, about 40 per cent of the medium and large scale entrepreneurs are engineering graduates (Table 2).

Product-wise educational qualification of entrepreneurs shows that majority of the technically qualified entrepreneurs in small scale industries (SSI) are in engineering (fabrication). Of the 23 small scale entrepreneurs in fabrication group, 19 have completed diploma and engineering degrees. Similar observation was made by Thangamuthu and Manimekalai (1989) who found that majority of the entrepreneurs (industrial estate) are engineering degree holders and they concentrate on fabrication and general engineering works. However, surprisingly there is no technical/diploma holders among medium and large scale entrepreneurs, excepting one medium scale entrepreneur who has MBA (Table 3).

Table 2: Education of the Entrepreneurs

Education	Tiny Scale Entrepreneurs		Small Scale Entrepreneurs		Medium and Large Scale Entrepreneurs	
	No. of Entrepreneurs	Percentage	No. of Entrepreneurs	Percentage	No. of Entrepreneurs	Percentage
Primary	2	3.50	2	2.82	–	–
Secondary	29	50.88	14	19.71	6	24.00
Higher Secondary	7	12.28	3	4.23	–	–
Graduates & Post Graduates	10	17.54	19	26.76	8	32.00
Technical Dip. Holders	8	14.04	13	18.30	–	–
Engineering Graduates	1	1.76	18	25.36	10	40.00
Professional Education (Other than Engineering)	–	–	2	2.82	1	4.00
Total	57	100.00	71	100.00	25	100.00

Source: Compiled from the primary data.

Performance

An analysis of entrepreneurial performance on the basis of the educational attainment of entrepreneurs (Tables 4, 5 and 6) reveals that in tiny scale units, technical degree/diploma holders exhibit better performance than non-technical entrepreneurs. Similarly, all the technically qualified entrepreneurs have attained better performance over the years than non-technically qualified in small scale industries also. Surprisingly, among the non-technical groups, the secondary education level entrepreneurs have consistently shown better perfor-

Table 3: Education by Product Line of the Entrepreneurs

Education	Primary			Secondary			Higher Secondary			Graduates and Post Graduates			Technical Dip. Holders			Engineering Graduates			Professional Other than Engineering			
Product line	Tiny scale units	Small scale units	Medium & large scale unite	Tiny scale units	Small scale units	Medium & large scale unite	Tiny scale units	Small scale units	Medium & large scale units	Tiny scale units	Small scale units	Medium & large scale unite	Tiny scale units	Small scale units	Medium & large scale unite	Tiny scale units	Small scale units	Medium & large scale units	Tiny scale units	Small scale units	Medium & large scale units	Total No. of Units
1.*	1	–	–	10	1	–	4	–	–	3	3	–	4	7	–	–	12	2	–	–	–	47
2.*	1	–	–	5	3	–	1	2	–	3	5	5	2	3	–	–	1	5	1	–	–	–
3.*	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
4.*	–	–	–	1	2	–	1	–	–	3	4	1	–	1	–	–	–	–	–	1	–	14
5.*	–	–	–	–	2	1	–	–	–	–	1	–	–	2	–	–	–	5	–	1	–	12
6.*	–	–	–	–	–	1	–	1	–	–	1	3	–	–	–	–	–	1	–	–	–	7
7.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
8.*	–	2	–	–	2	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	7
9.*	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10.*	–	–	–	5	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
11.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
12.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–
13.*	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14.*	–	–	–	8	1	2	1	–	–	1	2	–	1	–	–	–	–	1	–	–	–	17
Total	2	2	–	29	14	6	7	3	–	10	19	8	8	13	–	1	18	10	–	2	1	153

Source: Compiled from the primary data.

* Product Line as prescribed in Table 1.

Table 4: Mean Performance by Education of the Tiny Scale Entrepreneurs

Education	No. of units	Mean capacity utilisation (in percentage)			Mean number of workers (in. numbers)			Mean turnover (in. lakhs)			Mean profit (in lakhs)		
		1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97
Primary	2	55.00	64.00	64.00	4.00	6.00	6.00	0.79	0.66	0.62	0.12	0.10	0.10
Secondary	29	62.86	67.02	69.72	5.65	6.34	6.55	0.96	0.84	0.78	0.15	0.13	0.12
Higher secondary	7	60.43	62.43	68.57	5.71	6.43	6.57	0.95	0.87	0.77	0.14	0.12	0.11
Graduates & Post Graduates	10	64.40	66.70	69.40	5.30	6.00	6.10	0.99	0.82	0.79	0.15	0.13	0.12
Technical (Dip. Holders)	8	62.36	69.75	71.13	4.36	5.75	8.33	0.99	0.84	0.81	0.15	0.12	0.10
Engineering Graduates	1	70.00	75.00	75.00	6.00	6.00	6.00	0.81	0.65	0.62	0.17	0.13	0.13
Professional education (other than engineering)	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	57	61.57	66.81	69.62	5.37	6.19	6.42	0.96	0.82	0.78	0.15	0.15	0.11

Source: Compiled from the primary data.

mance than the graduates. This may be attributed to the fact that some of them have started their units as self-employment ventures after long experience/training. In medium and large scale units, entrepreneurs possessing engineering degrees and M.B.A. have good performance in mean capacity utilisation, number of workers, turnover and profit. Surprisingly, six entrepreneurs (medium and large scale) who have completed secon-

Table 5: Mean Performance by Education of the Tiny Scale Entrepreneurs

Education	No. of units	Mean capacity utilisation (in percentage)			Mean number of workers (in. numbers)			Mean turnover (in. lakhs)			Mean profit (in lakhs)		
		1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97
Primary	2	65.50	71.50	68.00	11.50	14.00	15.00	5.04	6.14	3.88	0.25	0.23	0.20
Secondary	14	69.00	73.00	73.21	18.86	21.21	23.00	7.14	6.67	6.23	0.56	0.46	0.41
Higher secondary	3	58.33	55.07	61.67	13.67	24.00	33.67	5.21	4.50	4.37	0.26	0.23	0.21
Graduates & Post Graduates	19	68.26	69.47	71.26	24.47	25.16	26.32	6.52	5.84	5.20	0.31	0.26	0.24
Technical (Dip. Holders)	13	68.54	70.77	72.77	20.54	21.85	22.85	6.76	5.71	5.11	0.40	0.34	0.34
Engineering Graduates	18	72.89	74.17	75.39	12.72	18.83	20.06	7.94	6.48	5.75	0.37	0.33	0.30
Professional education (other than engineering)	2	69.00	65.00	67.00	14.00	16.00	18.00	6.34	5.39	5.04	0.35	0.21	0.16
Average	71	67.04	69.78	72.29	19.53	21.73	23.20	6.83	5.97	5.91	0.39	0.33	0.30

Source: Compiled from the primary data.

Table 6: Mean Performance by Education of the Medium and Large Scale Entrepreneurs

Education	No. of units	Mean capacity utilisation (in percentage)			Mean number of workers (in. numbers)			Mean turnover (in. lakhs)			Mean profit (in lakhs)		
		1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97	1991-92	1994-95	1996-97
Primary	–	–	–	–	–	–	–	–	–	–	–	–	–
Secondary	6	71.67	75.17	75.67	176.33	182.33	225.17	74.11	68.46	65.73	2.62	2.36	2.37
Higher secondary	–	–	–	–	–	–	–	–	–	–	–	–	–
Graduates & Post Graduates	8	68.87	70.75	72.12	205.13	211.38	225.13	63.98	52.88	46.84	–0.52	–0.51	–0.45
Technical (Dip. Holders)	–	–	–	–	–	–	–	–	–	–	–	–	–
Engineering Graduates	10	68.60	70.20	71.20	73.50	78.60	73.50	48.67	40.09	36.61	1.21	1.04	1.00
Professional education (other than engineering)	1	63.00	65.00	65.00	57.00	60.00	72.00	57,34	45.70	40.95	1.35	1.49	1.41
Average	25	69.20	73.56	72.32	139.64	145.24	162.28	60.03	51.22	47.05	1.01	0.88	0.90

Source: Compiled from the primary data.

Table 7: Significant Test of Mean Performance of Technical and Non-technical Education of the Entrepreneurs

Education	Between Units	Between Education
Capacity Utilization (in. percentage)	2.13	0.46
No. of Workers (in. numbers)	3.72	0.988
Turnover (in. lakhs)	27.21*	0.97
Profit (in. lakhs)	0.00	0.00

Note: *Significant at 5 per cent level.

dary level school (non-technical) education have also registered fairly good performance, perhaps due to their prior experience.

However, Analysis of Variance (ANOVA) has shown that at five per cent level, there is no significant difference between the relative mean perfor-

mance of technical and non-technical entrepreneurs, in terms of capacity utilization, workers, turnover and profit.

Conclusion

In general, the study found no significant difference between the performance levels of technically qualified and non technically qualified entrepreneurs. In absolute terms, the performance profile of the secondary-level school educated entrepreneurs seem to be fairly better in most of the categories in almost all the categories of tiny, small and medium and large scale industries. Possibly, the school-level qualified entrepreneurs have longer work experience to their credit when compared with the technically qualified (at the post-secondary level) entrepreneurs. Thus, more than the type of education (technical or non-technical), experience and other promotional factors may play a vital role in nurturing entrepreneurship qualities and performance.

More than the type of education, experience and other promotional factors may play a vital role in nurturing entrepreneurship qualities.

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One pound of learning requires ten pounds of commonsense to apply it.

— Persian Proverb

Feature

Motivational Behaviour: Variation Across Hierarchical Levels

Padmakali Mishra & Gopa Bhardwaj

The present study was undertaken to examine the motivational pattern of the managerial personnel belonging to three hierarchical levels in a large private sector organisation. A group of 107 managers drawn from various departments and functions participated in the study. MAO-B (Pareek, 1997) was administered to the sample population to obtain the data pertaining to motivational behaviour. Results indicated achievement, extension, and influence to be the dominant motives/needs of the entire group of managers. Significant differences were also found among the three levels with respect to their dominant and dormant motives. Implications of results of the study have been discussed.

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The diversity of human motivation and its manifestation as human behaviour is one of the most enigmatic aspects of the management of organisation. The way a person behaves is, to a large part, a function of his/her motivation, i.e., his/her desire to fulfil certain needs. Thus, the work behaviour of people be it good, bad or indifferent, must be viewed in part as the consequence of the motivation of the individuals in question.

Motivation & Behaviour

The key to understanding motivation lies in the meaning of, and relationship among needs, drives, and incentives as depicted in the motivational cycle (Fig. 1) (Luthans, 1998):

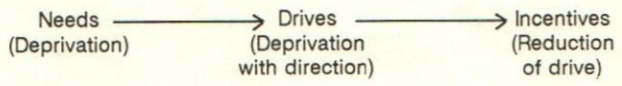

Fig. 1. Motivational Cycle

Needs: Needs are "the initiating and sustaining force of behaviour" or to put it simply, need is a deficiency. In the homeostatic sense, needs are created whenever there is a physiological or psychological imbalance.

Drives: Drives are set up to alleviate needs and are action-oriented.

Incentives: Incentive in the motivational cycle can be defined as anything which will alleviate a need and reduce a drive. Thus, attaining an incentive will tend to restore physiological or psychological balance and will reduce or cut off the drive.

Therefore, needs as we can see are the reasons underlying behaviour. All individuals have a number of needs, all of which are competing for expression but the need with the greatest strength at a particular moment

of time determines behaviour. A need tends to decrease in strength if it is either satisfied or blocked from satisfaction.

Murray (1938) used the concept of human needs as the basic unit of analysis and argued that individuals could be classified according to the strength of various personality related need variables which represent a central motivating force both in terms of intensity and direction of goal-directed behaviour. He also developed a long list of human motives or needs and his work has inspired further studies, which have produced different lists of significant behavioural motives.

Individuals could be classified according to the strength of need variables which represent a central motivating force both in terms of intensity and direction of goal-directed behaviour.

A person's behaviour in a work setting is acknowledged to be the result of several motives. Pareek (1988) has identified six primary motives relevant for understanding the behaviour of people in organisations. Operational definitions of these motives are as follows:

Achievement: Characterised by a concern for excellence, competition with the standards of excellence set by others or by oneself, the setting of challenging goals for oneself, awareness of the hurdles in the way of achieving those goals, and persistence in trying alternative paths to one's goals.

Affiliation: Characterised by a concern for establishing and maintaining close, personal relationship, a value on friendship, and a tendency to express one's emotions.

Influence: Characterised by a concern for making an impact on others, a desire to make people do what one thinks is right, and an urge to change matters and develop people.

Control: Characterised by a concern for orderliness, a desire to remain informed, and an urge to monitor and take corrective action when needed.

Extension: Characterised by a concern for others, interest in superordinate goals, and an urge to be relevant and useful to larger groups, including society.

Dependence: Characterised by a desire for the help of others in one's own self-development, checking with significant others (those who are more knowledgeable or have higher status, experts, close associates etc.), submitting ideas or proposals for approval, and having an urge to maintain an "approval" relationship.

All these needs or motives can be used to explain the behaviour of people in organisations. However, each of these motives can have two dimensions: approach and avoidance. Atkinson (1953) first suggested the concept of avoidance behaviour in discussing the achievement motive, distinct from "hope of success", which is the other component. Much research has been done on "fear of failure", which has been found to be dysfunctional although it is related to the achievement motive.

The concept of approach versus avoidance is also applicable to components of other motives referred to earlier. Thus, the behaviour of an employee or a manager can be explained in terms of the six motives but it can be analysed more accurately from the perspective of (positive) approach or (negative) avoidance, reflected by "hope of success" or "fear of failure". The approach and avoidance aspects of each of the six motives are presented in Fig. 2.

Motives	Approach (Hope of)	Avoidance (Fear of)
Achievement	Success	Failure
Influence	Impact	Impotence
Control	Order	Chaos
Extension	Relevance	Irrelevance
Dependence	Growth	Loneliness
Affiliation	Inclusion	Exclusion

Fig. 2. Approach and Avoidance Dimensions of Motives

The Present Study

Realising the significance of motivational behaviour in the organisation, the present study intended to analyse motivational behaviour of managerial employees with a view to understand what motivates them best or what kind of motivational strategies they possess as far as the experience of their surroundings or climates in concerned. The main objectives of the study were:

- To ascertain the nature of motivational behaviour of managerial personnel at senior, middle, and lower levels in a large private sector organisation.
- To determine whether significant differences exist across different levels of management on motivational behaviour.

Method

The study was carried out in a large private sector organisation located in the eastern part of India. The organisation is one of India's largest multi-business companies and study was undertaken in two units of the organisation, both engaged in manufacturing cigarettes. A sample of 107 managers was drawn randomly from all departments and functions of the organisation. More specifically, the sample consisted of 12 senior level managers, 41 middle level managers, and 54 lower level managers (total = 107). More details of the background profile of the sample are given in Table 1.

Table 1: Background Profile of the Sample (N = 107)

Demographic Variables	Frequency	%
Age		
23-23 years	53	49.5
34-44 years	36	33.7
45-55 years	15	14.0
Above 55 years	3	2.8
Education		
Post Graduate	10	9.3
Graduate	2	1.9
Professional Post Graduate	42	39.3
Professional Graduate	53	49.5
Work Experience (In the Present Job)		
1-5 years	36	33.7
5-10	18	16.8
Above 10 years	53	49.5
Marital Status		
Married	74	69.2
Unmarried	33	30.8
Total Monthly Income		
Rs. 5000-Rs. 10000	17	15.9
Rs. 10000-Rs. 20000	29	27.1
Rs. 20000 & above	61	57.0
Gender		
Male	68	63.6
Female	39	36.4

To attain the objectives of the study, the Motivational Analysis of Organisations Behaviour (MAO-B), developed by Pareek (1997), was used. The MAO-B consists of 60 items, five for each of approach and avoidance dimensions for each of the previously discussed motives, i.e., achievement, affiliation, influence, control, extension, and dependence.

The total score for each dimension (approach and avoidance) of the six motives can range from 5 to 20. The respondent's operating effectiveness quotient (OEQ) for each of the six motive-specific aspects of behaviour, defined by the net score of approach dimensions, can be obtained by using the formula:

$$OEQ = \frac{P-5}{P+V-10} \times 100$$

where P and V represent total scores for approach and avoidance dimensions respectively of a motive-specific behaviour.

A good rapport was established with the participants before administering any measure. They were assured that the data collected would be used for research purposes only and their responses would be kept strictly confidential. Firstly, they were asked to fill up the personal data sheet. Then, the instructions written in the measure used i.e., MAO-B, were explained to them. When the data collection was over, the standard procedure for scoring, as given in the manual, was followed.

Statistical analysis

For analysing the results of the MAO-B, means and SDs were calculated to know the nature of distribution of the operating effectiveness quotient (OEQ) for each of the six motives referred to earlier. To further ascertain the veracity of the results obtained, t-test was applied to find out the significant differences among different levels of management with respect to motivational behaviour.

Results & Discussion

Table 2 presents the OEQs for each of the six motives for the total sample in the private sector organisation covered under study. The results clearly indicate that the highest OEQ mean was on achievement motive followed by extension and influence motives. This implies that these were the dominant motives for the entire group of private sector managers. The possible reason for such a finding may lie in the fact that in the present day competitive environment, responsibilities fixed on the managers were numerous. They always tried to excel in their endeavour towards handling these responsibilities. Extension was accorded the second rank by the private sector managers. They realised that the goal of the organisation can not be achieved by a single person and that by doing their assigned work properly,

they were doing an immensely important service to the growth of the organisation. They were also trying to develop in themselves the power to bring an impact on others.

Table 2: Means, SDs and Ranks of OEQs of Various Motives for the Total Sample (N = 107)

Motives	Mean	SD	Rank
Achievement	57.07	4.72	I
Influence	56.31	4.30	III
Control	52.23	2.87	VI
Affiliation	52.90	2.55	V
Dependence	53.02	2.89	IV
Extension	56.54	4.36	II

The results further indicate that control motive had the lowest OEQ mean in the organisation. This finding can be explained by the relative importance being attached by managerial personnel to the quality of work rather than to prescribed rules and regulations. These results support the findings of Pareek (1988) who reported that achievement, influence, and extension motives promote effective performance. On the other hand, control, dependence, and affiliation motives reduce chances of effectiveness.

Achievement, influence, and extension motives promote effective performance. Control, dependence, and affiliation motives reduce chances of effectiveness.

Profiles of the three managerial levels in respect of OEQs for each motive have been shown in Table 3. A close perusal of the table reveals that of the three managerial levels, senior management level obtained higher OEQ means for all the six motives in comparison to the middle and lower management levels.

Significant differences were also observed between senior and middle managers on achievement, influence, control, affiliation, and extension motives. The reasons for such a finding may lie in the fact that senior managers had deeper insights into their job responsibilities and, being less in number, had distinct identity in the organisation. As a result, they were always striving for excellence in their work. They also exerted influence on their subordinates in order to achieve the organisational objectives. Further, they had to keep control and monitor the smooth running of the organisation by maintaining harmonious relations at the workplace.

The results further indicate a significant difference between middle and lower managers on affiliation motive. The lower level managers obtained higher mean score on this motive as compared to middle managers. One possible reason could be that since most of the lower level managers were relatively young and had joined recently, they formed strong groups based on common interests or other factors. They also tried to maintain good relations among themselves. Here, our results bring to light similarity in the trends of results with those of Sen (1982), and Pandey (1997), who reported existence of differences in OEQs for different motives along hierarchical levels in their studies of bank managers and rail engine drivers respectively.

Concluding Remarks

The findings of this study have far-reaching implications for optimisation of skills of managers working in private sector organisations. The fact that control, affilia-

Table 3: OEQs of Various Motives and Differences Across Three Hierarchical Levels

Motives	Senior Management (N = 12)		Middle Management (N = 41)		Lower Management (N = 54)		't'		
	M	SD	M	SD	M	SD	Senior vs. Middle	Senior vs. Lower	Middle vs. Lower
Achievement	61.83	3.01	57.07	3.50	56.02	5.21	4.26**	3.72**	1.12
Influence	60.33	3.80	55.78	3.02	55.81	4.79	4.33**	3.05**	0.04
Control	53.42	1.93	51.54	2.37	52.50	3.28	2.51*	0.93	1.59
Affiliation	54.25	1.54	52.07	2.21	53.22	2.79	3.19**	1.23	2.17*
Dependence	53.83	2.59	53.04	2.04	52.81	3.46	1.10	0.96	0.38
Extension	61.00	3.91	55.58	2.47	56.28	5.00	5.80**	3.06**	0.81

**p < .01 * > .05

tion, and dependence were found to be dormant motives for the entire group of managers covered under study indicates that the organisation can plan strategies for counselling of managers and providing them opportunities for establishing and maintaining close personal relationships with their peer groups and subordinates. Lack of such relationships may result in decreasing their efficiency as well as efficiency of the organisation. Further, control having been accorded the lowest rank indicates that managers were little concerned with orderliness and had little urge to monitor and take corrective action in relation to their work, when needed. This can be increased by developing strategies to give importance to the ideas given by the managers with regard to bringing improvements in their work. Since this study was carried out in a large private sector manufacturing organisation, the findings are not applicable to other types of organisations. Further, since the sample comprised only managerial personnel, the findings may be generalised to other categories of employees such as supervisors and workers with caution.

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No company can change any faster than it can change the hearts and minds of its people, and the people who change fastest and best are those who have no choice.

– Robert Frey

Feature

Excess Capacity in Cement Industry: Demand/Supply Constraints

K.S. Sujit

Cement industry in India has come a long way from a fully controlled industry to a liberalized one. A liberalized industry is expected to utilize its resources efficiently via market mechanism, as the idea of liberalization is to make market forces determine output, price and levels of capacity utilization. However, evidence shows that in cement industry the state (government forces) still plays a crucial role in allocating resources indirectly i.e. via creating demand. On the other hand supply factors though important determinants of capacity are overshadowed by lack of demand in Indian cement industry.

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Excess capacity in any industry is a matter of concern as it indicates failure of economic forces in allocating resources. However, excess capacities are sometimes voluntary to maintain fluctuations in demand or for some strategic reasons. In any case, excess capacity in a capital scarce country like India is not desirable as capacity utilization is directly linked to growth of economy. Recently, after liberalization many industries witnessed underutilization of capacity. This is quite contrary to the objective of liberalization policy, as one of its main objectives is to improve capacity utilization.

Capacity utilization is directly linked to growth of economy.

Since the nature of industries differs, determinants of capacity utilization also vary industry-wise (Srinivasan, 1992). A cross-section analysis by taking different industries at any point of time may miss industry specific determinants of capacity utilization. Hence this paper concentrates only on the determinants of capacity utilization in cement industry. The Cement industry in India is one such industry that has witnessed wide fluctuations in capacity utilization after liberalization. In general, either supply or demand factors can be held responsible for under utilization of capacity [Sastry (1980), Goldar *et al,* (1991), Srinivasan (1992), Varma (1991)]. Supply factors include availability of raw materials, infrastructure bottlenecks etc; demand factors include macro economic conditions or in other words, relative performance of the rest of the economy. However, structure of the market and conduct of the firms sometimes play significant role in determining utilization of capacity. It is hence essential to analyze the structure, conduct and performance (SCP) of Indian cement industry.

Structure, Conduct & Performance (SCP) of Cement Industry

The SCP paradigm has been the core for studying industrial organisations. The basic philosophy is that the relationship among these is inter-related and varies industry-wise (Hay & Morris, 1991). Structure of industry generally means the size and composition, which include number of firms, distribution of market share, size of firms etc. Cement as an industry in India is highly fragmented and distributed across the country in different zones. These zones play an important role in determining the supply and demand position in the country and hence the price of cement. Since transportation cost is very high for inter-regional movement of cement, the objective of cement firms is to create sufficient capacity in each region. Within each zone there are main players, which hold significant portions of cement market in their respective zones. However there are few major players, having sufficient control over the total cement production in India. These features are due to the fact that the structure of cement industry was influenced by factors like government control, availability of raw material in specific location and other locational advantages like railway station, ports etc.

Structure of cement industry was influenced by factors like government control, availability of raw material and other locational advantages.

Cement in India was a controlled commodity during independence and gradually it has opened up. These gradual changes from a controlled commodity to a decontrolled commodity brought about severe changes in the structure of the cement market in India. These changes can be categorized into three phases. The first phase can be considered as an era of full control over price and distribution of cement. This era continued for the period 1940- 1980. During the Second World War, cement was declared an essential commodity under the Defence of India Rules. This period did not witness considerable growth in cement production and installed capacity reached only 25.2 mt by the year 1980-81. The second stage was the period of partial decontrol, which was announced during 1982. This announcement allowed the industry to sell a portion in the open market and the rest by fixing levy cement quota. This period witnessed a marked change in terms of modernization and expansion of capacity. The installed capacity went up from 33 mt in 1982-82 to 44 mt in 1987-88. After the announcement of total decontrol, in the year 1989, the third period began followed by the delicensing of cement industry in 1991. Decontrol and delicensing of cement industry allowed market forces to determine demand and supply. This period marked major changes in the industrial structure and installed capacity of cement industry in India. Installed capacity witnessed a massive rise from 44 mt during 1989 to 110 mt during 1998-99 period. On the other hand the share of top four firms in the total industry fell after 1991-92 period as shown in Table 1. This fall in concentration ratio continued up to 1998 period.

Table 1: Share of top four firms in total installed capacity

Year	Cr4
1991-92	31.61
1992-93	30.27
1993-94	29.89
1994-95	29.33
1995-96	28.72
1996-97	29.83

Source: CMIE publications. March 2000

The fall in concentration is however attributed to the conduct of the firms, which includes major adjustment within the industry via mergers and acquisitions, and takeovers. Major acquisitions include Gujrat Ambuja (GACL) picking up a stake of 14 per cent in the Associate Cement (ACC), GACL taking over DLF Cement and MODI Cement, India Cement taking over Rassi Cement and Sri Vishnu Cement, Indian rayon's division merging with Grasim Cement, and Grasim taking over Sri Digvijay Cement, L&T, the current market leader in terms of installed capacity, taking over Narmada Cement. In the recent past multinationals like Lafarge, the French cement major has acquired the cement firms of Raymonds and Tisco. Italy based Italcementi has acquired 50 per cent stake in KK Birla promoted Zuari cement.

The free entry and exit of firms brought about major restructuring of the industry, which moved in favour of big players. Presently, out of installed capacity of over 110 million tones per annum, large plants account for 92 per cent of the total installed capacity in India. The figures of 2000 March show that the top four firm's share is about 32.27 per cent which is significantly higher than that during 1991-1997 period as shown in Table 2. On the other hand, there has been change in the share of dominant firms. Currently, the market leader in terms of capacity is Larsen and Toubro (L&T) with 12 million tones per annum followed by Associated cement companies (ACC), Grasim Industries and Gujrat Ambuja Cement (GACL) with 11.94, 10.18 and 8.20 million tones per annum capacity respectively.

Table 2: Company-wise Capacity

Companies	Present capacity in march 2000
L&T	12.05
ACC	11.94
Grasim industries limited	10.18
GACL	8.20
ICL	8.00
Others	60.33
All India	110.70
4-firms' share	32.27%

Source: CMA Publications

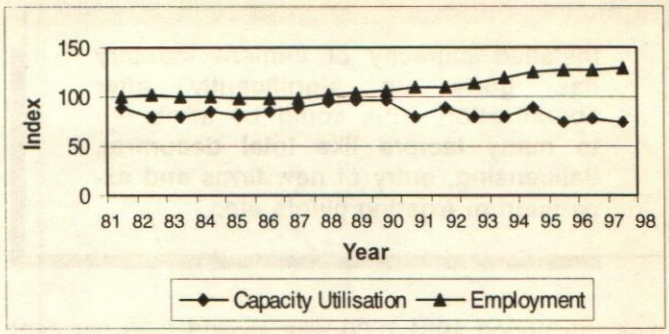

Fig. 1. Capacity Utilization and Employment

Source: CIER's Industrial Data book and Annual Survey of Industry (ASI)

It is evident from the tables that cement industry witnessed major changes in structure after the total de-control period, i.e. 1991, delicensing of cement industry, allowed new firms to enter and compete with the existing ones. MNCs like Italian major Italcementi and French company Lafarge Cement are also in the race to gain the market in India. With the entry of foreign companies, the structure became highly competitive and dynamic. In such a situation, mere production or investments in new plants may not be the right strategy for the cement industry. Efficient utilization of capacity could be an important area of concern. Capacity utilization not only allows the resources to be utilized efficiently but also enhances productivity, other things remaining constant.

Determinants of Capacity Utilization

Capacity utilization is considered an index of the efficiency of an industry. Full utilization of capacity of plant and machinery increases productivity and return on investment. This however, should be followed by efficient use of manpower and resources such as inventory, human resources and financial activities. Any diversion from full utilization is considered to be inefficient and a cost to the society for not utilizing the resources. The logic is, unutilized resources could be diverted to other productive purposes. This could be seen from the neo-classical perspective of U-shaped cost curve without any flexibility. This view is often criticized by the modern day economist – the present world situation where uncertainty plays an important role would force firms to have substantial excess capacity. Excess capacity in the firm allows the firm to be competitive in terms of variations in supply, owing to unanticipated events in the market. There is always some amount of excess capacity present in the industry. This could be seen from the data on capacity utilization in Indian cement industry as shown in Fig. 1. The level of capacity utilization never touched 10 per cent mark in any of these years. The highest capacity utilization level is recorded during 1988-90 period which is the golden period of cement industry with total decontrol and full flexibility. One interesting feature of capacity utilization in cement industry is that of wide fluctuations after liberalization of nineties, the causes of which can be understood by analyzing the demand and supply scenario of cement in India.

Full utilization of capacity of plant and machinery increases productivity and return on investment.

Demand and Supply Scenario

Cement is an essential product for various activities such as construction, housing, infrastructure etc. These activities are crucial for any country and this could be seen from the per capita consumption of cement. The world average per capita consumption of cement is around 250 kgs whereas in India it is around 80-85 kgs (CAS)[1]. India's per capita consumption of cement is significantly lower than that of world average. If India needs to be at par with that of world average, then it requires huge capacity and very high demand for cement. The demand in India comes mainly from housing construction i.e. sixty per cent of the total production. Rest of the demand comes from infrastructure and industrial use.

In India, the growth of demand and installed capacity had shown wide gap after the removal of various restrictions like controls and licensing. This mismatch between installed capacity and demand led to under utilization of capacity. This can be seen from Table 3. The rate of growth (ROG) of installed capacity

1. 'Current Demand and Supply Scenario' Crilsil Advisory Services-Corporates, May 2001.

Installed capacity of cement industry has gone up significantly after liberalization. This could be attributed to many factors like total decontrol, delicensing, entry of new firms and expansion of existing plants etc.

over the period 1981-2000 was around 8.06 per cent. The compound growth rate (CGR) was around 8.85 per cent. On the other hand, if the period is divided into two parts as pre-liberalization period i.e. 1981-1990 and post liberalization period i.e. 1991-2000, and growth rates compared then it is clearly shown that the rate of growth of installed capacity in these periods were 6.06 and 8.78 per cent respectively. This indicates that installed capacity of cement industry has gone up significantly after liberalization. This could be attributed to many factors like total decontrol, delicensing, entry of new firms and expansion of existing plants etc. On the other hand, demand shows a dismal performance as it did not grow as expected. Demand for cement grew at 5.52 per cent over the period 1981-2000. However, the growth rate of demand in the pre-liberalization period was 4.44 per cent whereas it was 7.46 per cent during post-liberalization period. Supply of cement grew at 7.69 per cent over the period. However the growth rate of supply was more during pre-liberalization period, i.e. 9.45 per cent compared to 7.75 per cent in the post liberalization period. On the other hand, the demand for cement during pre liberalization period was more than the supply. This can be seen from Fig. 2. Post-liberalization period witnessed more or less similar demand and supply situation. A high demand compared to low supply increases the price whereas excess supply as compared to demand brings the price down. This is exactly what happened in Indian case. Excess capacity has been created after liberalization period on anticipation of higher demand. As a result, price before liberalization was higher than that of post liberalization period. This can be seen from the wholesale price index (WPI) of cement.

Table 3: Rate of growth for period 1980-2000

Cement	Rate of growth (%)			Compound growth rate (%)		
	80-2000	81-90	91-2000	80-2000	81-90	91-2000
Demand	5.52	4.44	7.46	5.88	4.67	8.13
Supply	7.69	9.45	7.75	8.41	10.55	8.48
Installed capacity	8.06	6.06	8.78	8.85	6.50	9.73

The rate of growth is obtained using this function:

$\log Y_t = a + b$ (Time).

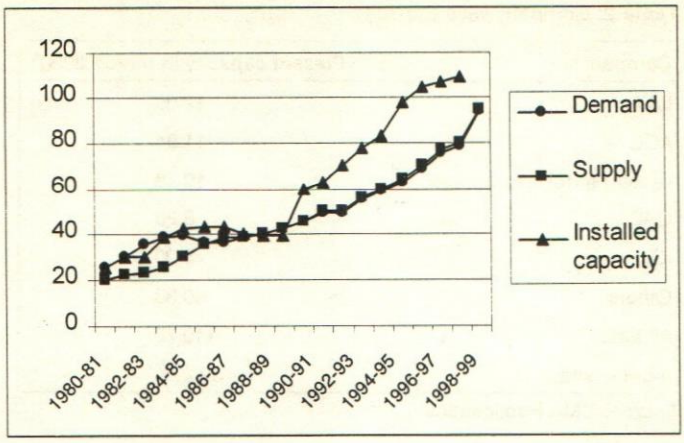

Fig. 2. Demand Supply and Installed Capacity

Source: CIER's Industrial Data Book 2000.

Causes of Underutilization of Capacity

One of the important determinants of industrial performance is capacity utilization. The utilization of capacity is dependent on various factors which can be broadly classified into two categories namely demand factors and supply factors. Demand factors include those from other sectors of the economy like agriculture, industry, etc., supply factors depend on factors like input cost, unbound logistics, selling cost and operational efficiency etc.

Demand for Cement

As mentioned, demand for cement comes from other sector of the economy. Cement is mainly used for housing, industrial use and infrastructure development. Recession in any one sector affects demand of cement. For example, a bad monsoon could badly affect cement demand or an industrial slowdown would have repercussion on it. The nature of market plays a significant role in determining cement demand in India. The cement market is fragmented, with four regions. Each region acts as a separate market due to high transportation costs associated with inter-region transportation. This could be the reason why there are price variations in different regions. For example, in deficit regions cement has to come from surplus regions and that includes transportation cost. Inter-region transportation is costly and hence it is not feasible to maintain uniform price in India.

The region-wise surplus cement production is shown in Table 4. It is clear that in southern and western region, there is continuous surplus of cement. This surplus has to be transported to other regions. Excess supply brings price down in that region; if the surplus

cement can be transported to other regions the price may remain stable.

Table 4: Surplus Demand and Supply (Region-wise) lakh MT

Year	Northern	Western	Eastern	Southern	Total surplus
1986-87	24	–29	36	–40	–9
1987-88	20	–37	37	–51	–31
1988-89	13	–45	40	–65	–57
1989-90	13	–53	43	–61	–58
1990-91	–54	66	–39	31	4
1991-92	–68	67	–50	54	3
1992-93	61	–66	41	–45	–9
1993-94	65	–75	41	–43	–12
1994-95	60	–76	37	–39	–18
1995-96	58	–71	31	–35	–17

Surplus - (demand – production). A negative sign indicates surplus in the region.

Source: CIER'S Industrial Data Book 2000.

The fragmentation of market is a hurdle in maintaining uniform price in Indian cement market (Table 5). However, demand of cement in each region depends on the overall economic activities, cement consumption is directly related to the Gross domestic product (GDP) and relative performance of other sectors of the economy. For the present analysis, three different sectors along with gross domestic production (GDP) are taken into consideration. These sectors are agriculture, industry and construction. Since there is a strong correlation among these indices as shown in Table 6, separate regression has been done for each variable to avoid multicollinearity. The result of regression is shown in Table 7.

Table 5: Retail Prices (Rs/50 kgs bag)

Region	1998-99	1999-00
Northern region	135.13	135.83
Eastern region	160.88	146.41
Southern region	138.43	135.01
Western region	133.70	133.77

CIEF's Industrial Data Book 2000.

Table 6: Correlation Matrix

	IIP	Agri index	Const index	GDP
IIP	1			
Agri index	0.975	1		
Const index	0.988	0.962	1	
GDP	0.998	0.982	0.989	1

Table 7: Demand for cement

Independent variable	Constant	Coefficient	R^2
IIP	9.64 (5.84)*	188 (23.18)*	0.97
Agri index	–25.61 (4.89)*	530 (13.85)*	0.92
Const index	–1.95 (.762)	.326 (19.23)*	0.95
GDP	1.84 (1.13)	.269 (28.14)*	0.98

Figures in brackets represent the t values and * represents the significance level at 1%.

For this analysis, demand for cement in India, as dependent variable, is regressed separately with index of industrial production (IIP), index of agricultural production (Agri index), construction index (const index) and gross domestic product (GDP). The result confirms that demand of cement depends on the performance of different sectors of the economy and overall economic performance. Recent slowdown of the economy could be one explanation for the slow growth rate for demand for cement in India.

Demand of cement depends on the performance of different sectors of the economy and overall economic performance.

Supply Factors

Supply factors that affect capacity utilization include the inputs required to produce cement along with the cost of transportation. The basic inputs include coal, limestone, power and labour. Over the years there has been a steep rise in the price of these inputs. However, the rise in the cement price is in downward direction as shown in Fig. 3. This is an interesting phenomenon where input prices are rising but final product price is falling. The fall in the price of cement can be attributed to factors like excess supply and fragmentation of the market. Excess supply in any one region forces cement price to fall as it is costly to transport from surplus region to deficit region. This can be seen from the inter region price variations shown in Table 5. Within regions also there is price variations depending mainly on the distance from the cement plants. Larger the distance, higher the price and vice versa.

Conclusion

It is clear from the analysis that demand for cement

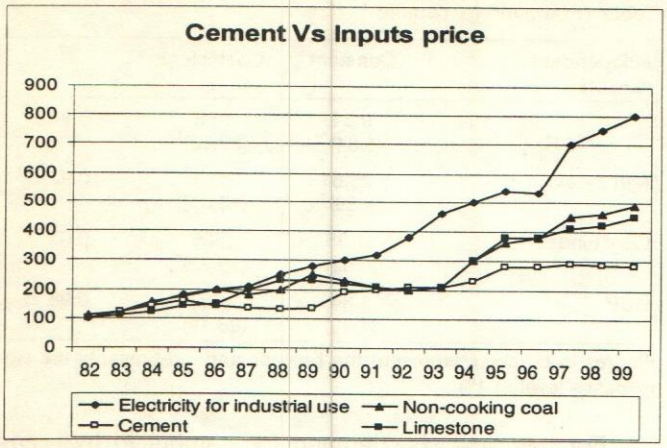

Fig. 3. Cement Price Vs Input Prices

Source: NIC website

is the crucial factor that determines capacity utilization. Though important Supply factors' impact is overshadowed by the presence of severe slowdown of demand with respect to installed capacity. This is the reason why price of cement has not grown vis-à-vis a rise in cement inputs. The recent housing and rural infrastructure program announced by the government of India has directly generated higher capacity utilization in India i.e. more than 85 per cent. Hence timely announcement of demand generation program is an important decision taken by the government of India to boost the demand and hence capacity utilization of cement.

Demand generation is key to capacity utilization and demand is determined by the relative performance of all the sectors in general and agriculture in particular. Hence the need is to concentrate on the rural sector in overall developmental activities like roads, houses etc.

Since the market is fragmented and transportation cost is high, the ideal solution for cement manufacturers is to consolidate their market share in each region and make them cost efficient; this could be in terms of operational efficiency or better technology. Apart from this, the manufacturers should diversify into related field like construction activities. This may generate demand on its own.

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The wisdom of the wise is an uncommon degree of common sense.

– William Ralph Inge

Feature

Productivity Growth in Zonal Railways

K.P. Sunny & V. Upadhyay

India a rail dominant economy in the 1950s became decidedly a road dominant one in the 1990s. This paper discusses the formation and spread of zonal railways in India. It analyses the trends in output growth and major factor inputs such as labour, capital and fuel growth across various zonal railways. Partial and total factor productivity performance levels for various time periods have also been analysed.

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Railway has a long history in India dating back to 1853 AD. Independent India inherited an extensive rail network of about 53400 route kms in 1947. India was a rail dominant economy in the 1950s; however, it became a road dominant one in the 1990s (World Bank, 1995). India's size, geography and resource endowments mandate a dominant role for the railways. Even though railways made substantial improvements in terms of passenger and freight traffic output during the past five decades, a secular decline has been observed in its share in total transportation of the country. Railways' share in total passenger traffic in the country declined from 74 per cent in 1950-51 to 20 per cent by 1996-97. In the case of freight traffic it declined from 89 per cent in 1950-51 to 40 per cent by 1996-97 (Ministry of Railways, 1998). Still Indian Railway is the second largest railway system in the world under a single management. Given this background this paper unravels the performance levels of Indian railways at a disaggregated level during the last three decades for getting an in-depth understanding on the problems that Indian Railways are facing today.

Formation of zonal railways in India

Even though railway operations started in 1953 AD, railway expansion was not always adequate to meet the social and economic needs of the nation. In general, demand for railway services exceeded its supply resulting in shortages across the country. After independence in 1947, state railways were taken over by the government. These state railways were merged with the contiguous railway systems and thus the Zonal railways were formed (Wadia, 1990). Railway system in India was divided into nine zonal railways by 1966-67. The number of zonal railways remained static till 1999 when seven more zonal railways were created by dividing some of the zones. Indian Railway is a monolithic system with nine zonal railways as its administrative units controlled and regulated by the railway board at the Centre. During the last 33 years of its operation (1967-99), zonal railways could add only 4342 kms of route length to the existing system at an annual growth of 0.22 per cent. At

all India level the route length increased at the rate of 132 kms per annum. Northern railways reported the highest route kms closely followed by western railways during the entire period. The lowest route kms has been reported from North East Frontier railways.

Output Growth in Zonal Railways

In this section trends in output during 1966-67 to 1998-99 period have been analysed. Freight ton kms and passenger kms have been considered as the major components of output in railway operation. Aggregate railway output has been estimated by summing up weighted passenger kms and freight ton kms, where the weights are taken from the respective revenue shares of passenger and freight traffic. Growth rates have been estimated separately for three sub periods and for the entire period. First sub period (1966-67 to 1975-76) coincides with the industrial stagnation in Indian Industries (Ahluwalia, 1985). Second sub period (1975-76 to 1990-91) denotes the industrial revival. Third sub period (1990-91 to 1998-99) represents economic liberalisation phase of the Indian economy. This periodisation would help in comparing and understanding the productivity performance of railways, particularly zonal railways, during different policy regimes.

Indian Railway has a route length of 62809 kms and operates 11000 trains in a day including 7500 passenger trains. It carries 11 million passengers and 1.2 million tons of freight on a daily basis. Passenger traffic in railways increased from 185 kms per passenger in 1950-51 to 350 kms per passenger by 1998-99. Freight traffic increased from 123 net tonne kms per person in 1950-51 to 293 NTK per person by 1998-99 (Annual Report & Accounts, various years).

Aggregate output (weighted) in Indian Railways has been increasing 3.43 per cent per annum for the last 33 years (Table 1). The highest growth rate for the entire period was reported from Central railway at 4.21 per cent per annum. The lowest output growth rate has been observed from Northeast Frontier railway at 2.27 per cent per annum. Output growth during the first period (1966-67 to 1975-76) exhibited the lowest growth across the zonal railways as compared to later two sub-periods. Various factors such as Indo-Pak war in 1971, railway employees all India strike during 1974, first oil shock of 1973 etc., adversely affected zonal railway performance during this period. Second phase (1975-76 to 1990-91) exhibited higher growth rates in output as compared to other two sub periods across all the zonal railways. During the third sub period (1990-91 to 1998-99), aggregate output growth exhibited lower growth across most of the zonal railways (Table 1). Output growth for North East Frontier railway exhibited negative growth during the last phase. Only in four zonal railways such as Central, North Eastern, South Eastern and Southern, output has been found increasing above 3 per cent per annum. It may be noticed that after the introduction of economic liberalisation, output growth in zonal railways exhibited a declining trend.

Table 1: Aggregate Output* growth across zonal railways (% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	3.05	4.11	3.91	4.21
Eastern	–0.03	2.71	2.19	2.41
Northern	3.11	4.03	1.92	3.48
N. Eastern	1.71	3.32	4.95	3.69
N. Frontier	1.76	2.64	–0.04	2.27
Southern	1.11	2.91	4.05	3.02
S. Central	4.76	4.51	2.45	4.18
S. Eastern	2.46	3.52	4.11	3.74
Western	3.09	3.49	1.91	3.42
All India	2.37	3.61	2.67	3.43

Note: * Aggregate output is computed from Passenger kms (in billions) weighted with passenger earning shares; goods ton kms (billion NTKs) weighted with goods earning shares in total traffic earnings of railways. Growth rates are estimated from an exponential fit of aggregate output w.r.t. time.

Source: Annual Statistical Statements (Various years)

Table 2: Average annual growth of Passenger kms and Freight ton kms during 1966-67 to 1998-99(%)

Zonal Railways	Passenger kms	Freight Ton kms	Aggregate Output
Central	5.75	2.56	4.21
Eastern	3.63	1.80	2.41
Northern	4.39	3.22	3.48
N. Eastern	4.61	2.60	3.69
N. Frontier	2.51	2.69	2.27
Southern	3.61	1.52	3.02
S. Central	5.12	4.21	4.18
S. Eastern	3.97	3.87	3.74
Western	4.35	2.83	3.42
All India	4.40	2.82	3.43

Note: Growth rates are estimated from an exponential fit

Source: Estimated from Ministry of Railways-Annual Statistical Statements (Various years)

We may also analyse growth in the components of aggregate output (freight tonne kms and passenger kms) separately for the zonal railways. Freight tonne

kms have been found growing at an average annual rate of 2.82 per cent at all India level (Table 2). The highest growth in freight tonne kms has been found at South Central railway (4.21 per cent per annum) while the lowest growth was found at Southern railway (1.52 per cent per annum). Passenger kms have been growing at 4.4 per cent per annum with Central zone having the highest growth at 5.75 per cent and North East Frontier having the lowest growth rate at 2.51 per cent per annum. From the output analysis it may be noted that the freight output in the railways grew at a very low rate of 2.82 per cent while the passenger output grew at a much higher rate of 4.4 per cent per annum during the entire period.

During the eighties, major operational changes became effective in the Indian Railway system. These included rationalisation of freight movements with a very strong emphasis on block rake movements, segregation of different types of rolling stock to speed up the throughput and increase in the train inspection intervals (Sunny, 2001). These changes are no doubt related to the changes in demand for rail services but they also appear to be linked to significant management intervention in operating and maintenance practices. However, the momentum lost its steam by the beginning of nineties.

Trends in input growth across zonal railways

Three major factor inputs, namely labour, capital and fuel have been considered for a detailed analysis. In the following sections we analyse the trends in factor inputs growth during the last 33 years.

Trends in Labour force Growth

Labour force in railways increased at a moderate annual rate of 0.55 per cent during 1966-67 to 1998-99. Among the zonal railways, only South Central railway exhibited more than one per cent annual growth in labour force; the lowest growth rate has been found at North East Frontier Railway at 0.06 per cent per annum. It may be noted that during the last period under study (1990-91 to 1998-99), labour force started showing negative growth across all the zonal railways except Northern Railway (Table 3). At the all India level, labour force was growing at a higher rate during the first period (1966-67 to 1975-76) as compared to second and third periods. Employment in railways reached its peak strength during 1991-92 at 15.84 lakhs. However, by 1998-99, number of employees declined to 15.09 lakhs. During this period, we notice a substantial decline in labour force to the extent of 74 thousand personnel across all the zonal railways. However, salary and wages witnessed an annual growth of 13.5 per cent during 1991-99 period.

Table 3: Employment growth across Zonal Railways (Group A, B, C & D)

(% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	0.39	1	–0.34	0.83
Eastern	0.72	0.45	–1.19	0.38
Northern	0.71	0.68	0.03	0.84
N. Eastern	0.57	0.81	–1.57	0.31
N. Frontier	0.65	–0.19	–0.94	0.06
Southern	0.17	0.67	–1.25	0.28
S. Central	1.59	1.33	–0.24	1.06
S. Eastern	1.85	0.48	–2.67	0.56
Western	0.69	0.61	–1.51	0.31
All India	0.82	0.66	–0.73	0.55

Source: Estimated from Annual Statistical Statements (Various years)

Labour force in railways comprises four different categories of employees. Group A&B are supervisory staff who are educated and skilled as compared to group C&D who are unskilled. It may be noted that the ratio of Group A&B staff in labour force at all India level nearly doubled from 0.47 per cent in 1967 to 0.80 per cent in 1999. It indicates that the educational profile of the labour force improved over the years in Indian railways and railway operation has become more technology oriented. At the zonal level also, we find almost the same trend.

Trends in Capital stock across Zonal Railways

Capital stock for the zonal Railways has been built up on the basis of Perpetual Inventory Method (PIM). All capital additions have been adjusted to 1980-81 prices using component specific factor prices. No adjustments have been made for capacity utilisation due to lack of data. Three major components of capital, namely structural engineering works, rolling stock and equipment, which together comprise nearly 85 to 90 per cent of total capital investment of railways, have been considered for capital stock estimation. Each of these capital components has been deflated with factor specific price indices. Applying these price indices, capital stock has been estimated at 1980-81 prices for all the zonal railways during 1966-67 to 1998-99 period.

Structural engineering works, which comprise nearly 57 per cent of the total capital stock in 1966-67, grew

Table 4: Shares of various components of capital stock for select years (%)

Years	Component	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	South Central	South Eastern	Western	All India
1966-67	S.E. Works	55.7	50.3	57.5	53.6	71.0	49.0	71.0	60.3	54.5	57.1
	Roll. Stock	38.5	45.0	39.3	41.4	23.3	47.2	25.9	37.2	40.6	38.7
	Equipment	5.8	4.8	3.1	5.0	5.7	3.8	3.1	2.5	4.9	4.2
1975-76	S.E. Works	53.6	43.8	52.0	58.7	68.5	54.0	67.4	55.5	49.3	54.0
	Roll	Stock	40.3	50.2	42.7	35.8	26.7	42.1	29.2	41.2	45.4
	Equipment	6.1	6.0	5.3	5.5	4.8	4.0	3.5	3.3	5.3	4.8
1990-91	S.E. Works	53.2	43.3	57.5	66.8	74.4	59.5	59.3	56.3	58.6	56.8
	Roll. Stock	32.7	44.3	32.0	22.2	16.1	28.1	30.7	34.7	31.6	32.2
	Equipment	14.1	12.3	10.5	11.1	9.5	12.3	10.0	9.0	9.8	11.0
1998-99	S.E. Works	54.3	38.5	58.6	72.3	78.2	65.0	61.0	62.7	62.6	59.3
	Roll. Stock	31.7	48.4	30.5	13.5	11.0	23.3	26.5	27.3	25.7	28.7
	Equipment	14.1	13.1	10.9	14.1	10.8	11.7	12.4	9.9	11.7	12.0

Note: S.E. Works represents Structural Engineering Works & Roll. Stock represents rolling stock

Source: Estimated from Appropriation Accounts – Annexure G, Ministry of Railways (various years)

to 59 per cent by 1998-99 (Table 4). Rolling stock share exhibited a declining trend (38.7 per cent in 1966-67 to 28.7 per cent by 1998-99) while equipment share improved substantially from a meagre 4.2 per cent in 1966-67 to 12 per cent by 1998-99. It is mainly due to the introduction of modern technology such as computerisation, automation etc.

Table 5: Capital Stock Growth across Zonal Railways (% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	5.03	3.31	3.83	3.69
Eastern	3.27	3.88	4.89	3.59
Northern	4.75	4.19	4.57	4.27
N. Eastern	2.36	4.61	4.65	4.16
N. Frontier	0.79	3.07	4.83	2.78
Southern	4.32	2.63	5.97	3.48
S. Central	6.63	5.48	6.29	5.47
S. Eastern	6.88	1.73	3.53	2.72
Western	5.07	3.95	4.29	4.17
All India	4.76	3.49	4.63	3.76

Note: Growth rates are estimated from an exponential fit of the capital stock

Source: Estimated from Appropriation Accounts, Annexure G, Ministry of Railways (Various Years)

Aggregate Capital stock in Indian Railways exhibited an annual growth of 3.76 per cent (Table 5). It increased from Rs. 5571 crores in 1966-67 to Rs. 20951 crores by 1998-99 at all India level at 1980-81 prices. Among the zonal railways, Northern railway got the highest share of capital stock at 16 per cent, while the North East Frontier railway has the lowest share at 5 per cent of the total capital stock during 1998-99. Wide variations in capital stock growth was observed across zonal railways with South Central zone reporting the highest growth while South Eastern the lowest. It may also be noted that during the second phase (1975-76 through 1990-91), capital stock reported the lowest growth across most of the zonal railways except North East Frontier Railways.

Trends in Fuel consumption across Zonal Railways

Indian Railway consumes various types of fuel for its operations. Major portion of fuel goes for traction purposes, however, production units also use a small proportion. Mainly coal, diesel, petrol and electricity fuels are consumed for traction purposes. The quantum of coal consumption has gone down substantially over the years with progressive dieselisation and electrification. Correspondingly, the inputs of diesel oil and electricity have shown a rising trend.

Total fuel excluding electricity consumption in Railways converted into coal replacement units declined from 20 million tonnes in 1966-67 to 18 Million tonnes by 1998-99. However, electricity consumption exhibited tremendous increase from a meagre 6 lakh thousand kilo watt hours (tkwhrs) in 1966-67 to 60 lakh tkwhrs by 1998-99 (Annual Statistical Statements, various years).

Total fuel including electricity consumption in Rail-

ways converted into coal replacement units has been found growing at a moderate level of 0.36 per cent per annum during the entire period (1966-67 to 1998-99) (Table 6). This indicates that fuel efficiency improved considerably across the zonal railways during 1966-67 to 1998-99 period. As a result of it Railways could handle more passenger and goods traffic with lesser fuel consumption. A closer examination of the data reveals that a shift in traction technology from steam to diesel and then to electricity has significantly contributed towards improvement in fuel efficiency.

Shift in traction technology from steam to diesel and then to electricity has significantly contributed towards improvement in fuel efficiency.

Table 6: Total Fuel* consumption growth across Zonal Railways (% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	–1.21	1.46	0.02	0.56
Eastern	–0.03	0.28	0.19	0.04
Northern	0.94	1.19	–0.87	0.9
N. Eastern	3.68	1.92	–5.97	0.96
N. Frontier	–5.24	0.55	–1.29	–0.36
Southern	1.03	–1.46	0.94	–0.69
S. Central	3.54	1.72	–0.05	1.95
S. Eastern	–0.28	0.91	2.08	0.59
Western	1.02	–0.14	–0.82	–0.29
All India	0.09	0.68	–0.23	0.36

Note: *Total fuel in railways has been estimated on the basis of Planning Commission 1979 conversion ratios.

Source: Estimated from Annual Statistical Statements (Various years)

Partial Productivity Analysis across zonal railways

Three major factor inputs used for railway transportation could be identified as labour, capital and fuel. It may be noted that factor specific productivity indices are only partial indicators denoting the extent to which efficiency could be achieved in specific factor use. The partial productivity of labour, capital and fuel has been seen as the ratio of aggregate output to labour, capital and fuel inputs respectively.

Labour Productivity growth across Zonal Railways

Labour productivity in Railways considerably improved during the second and third periods as compared to the first period. Labour productivity across all the zonal railways improved considerably during the last 32 years. Labour productivity growth in North East Frontier railway declined to just 0.89 per cent during 1991-99 period from as high as 2.83 per cent during 1976-91 period (Table 7). Various non-economic factors have been found responsible for this decline in labour productivity at North East Frontier railway. For example, we observe a decline in output during the later years as a result of political instability and militant attacks on rail tracks in this region. In the case of South Eastern railway we notice substantial increase in freight traffic in the later years, particularly after 1983-84 as a result of bulk/rake movement of goods such as coal, iron ore etc., as raw material to industries and thermal power stations in the country. This zone has been serving as a major supplier of raw materials to other parts of the country. During 1998-99, considerable decline in labour productivity has been observed in South Eastern railway, primarily due to the impact of severe cyclone, which ravaged the coastal districts of Orissa and West Bengal during 1998-99.

Table 7: Labour Productivity growth across zonal railways

(Annual percentage growth)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	2.66	3.11	4.25	3.39
Eastern	–0.75	2.26	3.39	2.03
Northern	2.40	3.35	1.88	2.64
N. Eastern	1.14	2.51	6.52	3.39
N. Frontier	1.11	2.83	0.89	2.21
Southern	0.94	2.25	5.30	2.75
S. Central	3.17	3.18	2.69	3.13
S. Eastern	0.60	3.04	4.37	3.18
Western	2.40	2.87	3.43	3.11
All India	1.55	2.95	3.39	2.88

Note: Growth rates are estimated from an exponential fit of labour productivity.

Source: Estimated from Annual Statistical Statements, Ministry of Railways, (Various Years)

Trends in Labour productivity across various zonal railways for the period 1966-67 to 1998-99 are given as an index in Table 8. The index values are computed from the following equation.

$$I_T = I_{T-1} (1 + GR_T)$$

Where I_T represents the index value for the current year and GR_T represents annual growth rates.

Table 8: Trends in Labour Productivity across Zonal railways

Years	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	S. Central	S. Eastern	Western	G. Total
1966-67	100	100	100	100	100	100	100	100	100	100
1975-76	121	108	129	119	125	99	143	126	131	121
1980-81	143	102	154	135	108	112	161	126	154	134
1985-86	176	122	184	142	139	134	207	153	170	160
1990-91	193	141	205	194	178	148	233	203	208	188
1995-96	244	168	211	272	191	179	265	271	256	223
1996-97	253	176	224	279	192	192	279	274	254	230
1997-98	257	181	233	300	185	208	289	293	266	239
1998-99	273	181	239	327	190	216	289	277	282	245

Source: Estimated from year to year growth rates

It may be noted that the index of labour productivity increased by two and half times over the years. In the case of five zonal railways viz., Central, North Eastern, South Central, South Eastern and Western railways, the index of labour productivity increased more than two and a half times. During 1973-74, there was a decline in labour productivity as a result of railway unions strike (Sherlock, 2001). During 1998-99, the lowest labour productivity index was reported from Eastern railways (190) and the highest from North Eastern railways (327).

Capital Productivity Growth across the Zones

Capital stock grew at a higher rate than other factor inputs during the entire period. This resulted in sharp decline in capital productivity across the zonal railways. Zonal analysis shows that in most of the zonal railways, capital productivity growth has been negative except in Central and South Eastern railways (Table 9). During the first period (1966-67 to 1975-76), only North East Frontier railway reported positive growth rates. However, during the second period (1975-76 to 1990-91), three zonal railways viz., Central, Southern and South Eastern exhibited positive growth rates. In the last phase, we notice positive capital productivity growth for Central, North Eastern and South Eastern zonal railways. Northern, Eastern, South Central and Western railways exhibited negative capital productivity growth rates for all the three sub periods.

A secular decline in capital productivity growth index has been observed across all the zonal railways during the last 33 years. Some of the zonal railways such as Northern, Northeast Frontier, North Eastern and South Eastern exhibited considerable fluctuations in capital productivity growth index during the second period (Table 10). Only in South Eastern railway, we could observe an increase in capital productivity growth index well above the base year level by 1998-99. This indirectly indicates that among the zonal railways, South Eastern railway got the lowest share of capital investment during the study period.

Table 9: Capital Productivity Growth across zonal railways (% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	–1.98	0.80	0.08	0.52
Eastern	–3.30	–1.17	–2.69	–1.18
Northern	–1.64	–0.16	–2.66	–0.79
N. Eastern	–0.65	–1.29	0.29	–0.46
N. Frontier	0.96	–0.43	–4.87	–0.51
Southern	–3.21	–0.29	–1.92	–0.46
S. Central	–1.86	–0.97	–3.85	–1.28
S. Eastern	–4.42	1.79	0.58	1.02
Western	–1.97	–0.46	–2.37	–0.75
All India	–2.39	0.13	–1.96	–0.33

Note: Growth rates are estimated from an exponential fit of capital productivity w.r.t. time.

Source: Estimated from Annual Statistical Statements and Appropriation Accounts-Annexure G, Ministry of Railways, (Various Years)

Fuel Productivity at the zonal railways

Fuel productivity during 1966-67 to 1998-99 period was found growing at the rate of 3.07 per cent per annum. During the first period of the study (1966-67 to 1975-76), fuel productivity was found growing at the rate of 2.28 per cent per year at all India level (Table 11). Fuel productivity growth during the first phase was found negative for North Eastern railway. However, all other zonal railways exhibited positive growth rates during this period. During the second period (1975-76 to 1990-

Table 10: Trends in Capital Productivity across Zonal railways

Years	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	S. Central	S. Eastern	Western	G. Total
1966-67	100	100	100	100	100	100	100	100	100	100
1975-76	76	80	90	98	122	67	93	78	87	83
1980-81	88	73	102	97	107	70	83	73	97	86
1985-86	98	74	105	93	112	75	87	89	93	91
1990-91	89	65	88	89	110	72	82	99	85	85
1995-96	89	58	69	92	92	65	65	66	111	76
1996-97	91	55	72	87	86	65	66	106	72	75
1997-98	90	57	72	89	77	63	64	108	72	75
1998-99	92	54	72	91	78	61	64	100	73	74

Source: Estimated from year to year growth rates

91), we observe considerable improvement in fuel productivity across all the zonal railways. During the third period (1990-91 to 1998-99), fuel productivity growth remained more or less the same as compared to second period for most of the zones except North Eastern railways where we notice substantial improvements in productivity.

Table 11: Fuel Productivity growth in zonal railways (% per year)

Zonal Railways	1966-67 to 1975-76	1975-76 to 1990-91	1990-91 to 1998-99	1966-67 to 1998-99
Central	4.26	2.65	3.88	3.66
Eastern	0.00	2.43	1.99	2.37
Northern	2.17	2.84	2.79	2.58
N. Eastern	–1.97	1.39	10.92	2.73
N. Frontier	7.00	2.09	1.25	2.63
Southern	0.08	4.37	3.11	3.71
S. Central	1.23	2.79	2.49	2.24
S. Eastern	2.74	2.61	2.02	3.16
Western	2.08	3.63	2.73	3.71
All India	2.28	2.93	2.90	3.07

Note: Growth rates are estimated from an exponential fit w.r.t. time.

Source: Estimated from Ministry of Railways, Annual Statistical Statements, (Various Years)

South Central railway exhibited the lowest fuel productivity growth index (131) during 1998-99 whereas highest index was found in North Eastern zone at 347 (Table 12). During 1998-99, five zonal railways namely, Central, Northern, North Eastern, South Eastern and Western reported fuel productivity index lower than all India level.

Comparison of Partial Productivity Growth Trends

A comparison of partial productivity indices for various factor inputs shows that maximum productivity gains have been achieved by labour and fuel inputs. Labour productivity index for 1998-99 ranges between 180 to 327 for different zones. Higher labour productivity has been achieved mainly through reductions in labour force during the last eight years. The next best improvement has been in respect of fuel productivity where 1998- 99 indices range between 131 to 347 for different zonal railways (for all zones, it is 247). Aggregate fuel consumption in coal replacement units exhibited very little increase during the last 33 years; hence it contributed positively to fuel productivity. Labour and fuel productivity indices have been moving more or less in the same range (with fuel showing relatively a little more variation).

The best labour productivity index during 1998-99 has been reported from North eastern railways and the lowest from Eastern railways. In the case of fuel productivity index, North Eastern railway reported the highest level at 347 and the lowest level from South Central railways at 131. Capital productivity index has been found below the initial level in most of the zonal railways except South Eastern railway. The lowest capital productivity growth index was reported from Eastern railway at 54. It shows that the relative share of capital stock in Eastern railway has gone up as compared to other zonal railways during the study period.

Total Factor Productivity Growth across zonal railways

Total factor productivity has been estimated on the basis of Translog index for each zonal railways. It is assumed that aggregate output (Yi) can be expressed as a translog function of capital input (Ki), labour input (Li), intermediate fuel input (Fi) and time (T) (Jorgenson, Gollop & Fraumeni, 1987). The corresponding index of

Table 12: Trends in Fuel Productivity index across Zonal railways

Years	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	S. Central	S. Eastern	Western	G. Total
1966-67	100	100	100	100	100	100	100	100	100	100
1975-76	138	109	127	121	129	102	77	140	123	121
1980-81	167	105	151	141	135	153	66	149	168	138
1985-86	193	125	167	140	150	204	85	178	186	161
1990-91	236	165	206	168	179	200	110	223	228	197
1995-96	294	178	220	336	184	234	140	290	279	236
1996-97	308	186	231	329	190	245	153	266	280	241
1997-98	316	197	245	359	193	256	133	272	287	245
1998-99	334	200	257	347	207	246	131	259	279	247

Source: Estimated from year to year growth rates

Table 13: Total Factor Productivity growth across zonal railways (% per year)

Years	Central	Eastern	Northern	North Eastern	N.E. Frontier	Southern	South Central	South Eastern	Western	All India
1967-76	0.17	–2.16	0.73	–0.87	1.13	–2.17	0.94	–0.32	0.74	–0.25
1976-91	2.57	1.79	2.12	2.09	2.14	2.46	1.97	3.64	2.47	2.45
1991-99	3.27	0.91	0.16	5.03	–1.81	3.06	0.69	1.76	1.76	1.49
1966-99	2.27	0.71	1.48	2.65	0.69	1.52	1.19	1.91	1.87	1.56

productivity is the translog index of the rate of productivity growth (TFPi).

$$TFP_T = [\ln Y_{i(T)} - \ln Y_{i(T-1)}] - \overline{W}_k [\ln K_{i(T)} - \ln K_{i(T-1)}] - \overline{W}_l [\ln L_{i(T)} - \ln L_{i(T-1)}] - \overline{W}_f [\ln F_{i(T)} - \ln F_{i(T-1)}]$$

Where weights have been estimated as average value shares of capital, labour and fuel in total expenditure of each of the zonal railway:

$$\overline{W}_k = \tfrac{1}{2} [W_{k(T)} + W_{k(T-1)}]$$

$$\overline{W}_l = \tfrac{1}{2} [W_{l(T)} + W_{l(T-1)}]$$

$$\overline{W}_f = \tfrac{1}{2} [W_{f(T)} + W_{f(T-1)}]$$

Total Factor Productivity growth estimated from this method has been found growing at an annual rate of 1.56 per cent during 1966-67 to 1998-99 at all India level (Table 13).

The highest TFP growth has been reported from North Eastern railways at 2.65 per cent per annum. The lowest TFP growth rate was observed in North East Frontier railway at 0.69 per cent per annum. It may be noted that during the first period (1966-67 to 1975-76) TFP exhibited negative growth at all India level. Four zonal railways, namely Eastern, North Eastern, Southern and South Eastern reported negative TFP growth during the first period. During the second period (1975-76 to 1990-91), considerable improvement in TFP growth has been noticed across all the zonal railways. The overall TFP growth during this period was at 2.45 per cent per annum. However, during the third phase (1990-91 to 1998-99), TFP shows a decline over the previous period. During this period, all with the exception of North Eastern Frontier railways exhibited positive TFP growth; however, the overall growth was found to be lower than the previous period. This period corresponds to economic liberalisation of Indian economy. The impact of liberalisation on the performance of zonal railways shows wide differences. While in the case of Central, North Eastern and Southern zones, the impact has been positive on the rate of growth of TFP, in case of other zones the rate of growth of TFP has declined during the liberalisation period.

In the case of Central, North Eastern and Southern zones, the impact of liberalisation has been positive on the rate of growth of Total Factor Productivity, in other zones the rate has declined.

Table 14: Total Factor Productivity Growth Index across Zonal Railways

Years	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	S. Central	S. Eastern	Western	All India
1966-67	100	100	100	100	100	100	100	100	100	100
1975-76	109	97	114	109	120	89	110	106	113	107
1980-81	126	91	133	118	106	103	110	103	134	116
1985-86	147	102	148	118	119	119	131	125	138	132
1990-91	155	109	151	142	132	124	142	151	151	143
1995-96	181	117	139	187	123	138	141	183	166	154
1996-97	187	119	146	187	120	145	147	178	163	156
1997-98	190	122	150	199	112	152	144	185	168	159
1998-99	199	121	154	212	114	154	143	173	173	161

Source: Estimated from year to year growth rates

TFP growth is presented in an index form for all the years during 1966-67 to 1998-99 (Table 14). At the all India level, we may notice that TFPG started growing above 100 only after 1975-76. By 1998-99, it has grown to 161. Among the zonal railways, North Eastern railway reported the highest index at 212 and North East Frontier the lowest at 114.

Relative Ranking of Zonal Productivity Performance

This section ranks and compares the relative productivity performance across various zonal railways with a view to identifying the critical factors that determine zonal performance. In the earlier sections the trends in output, input, partial productivities and total factor productivity across all the zones were compared. However, due to variations in productivity performance in terms of each one of the indicators, a clear picture was not emerging. Therefore, in this section all the performance indicators are summarized in terms of their respective ranks for each of the zonal railways. The zonal railways are also ranked in terms of their composite productivity indicators. The zones having the highest growth rates are ranked first and the remaining zones are ranked as per their growth rates. These individual ranks with respect to various productivity variables are added up for getting a composite number for each zonal railway. The zone having the lowest composite number is assigned first rank. Accordingly all the zonal railways are ranked as per their composite numbers.

Central railway operates in the heartland of India ranging from Delhi in the north, Mumbai in the west, Gulbarga in the South and Shaktinagar in the East. In this vast stretch of land, major industries, thermal stations, urban centres etc are situated. During the first period (1966-67 to 1975-76), Central railway reported third rank among the zonal railways in terms of composite ranking of various performance indicators (Table 15). During the second period, Central Railway improved its performance levels and stood first among zonal railways in terms of the composite ranking. However, during the third period (1990-91 to 1998-99), it was found second among the zonal railways. For the entire period, Central railways has been found to be the best performing zonal railway.

Central railways is the best performing zonal railway.

Eastern railway operates in the geographical area between Mughal Sarai in the west, Bhagalpur in the north, Chandrapura in the south and Diamond Harbour in the east. Eastern railway reported the worst performance among the zonal railways during the first period of the study with respect to most of the performance indicators. The composite ranking also exhibited Eastern railway as the worst performing zonal railway during the first and second periods of the study. Considerable improvement in various productivity indicators took place during the third period as its rank improved to 6th position (Table 15). For the entire study period, Eastern railway reported the lowest productivity performance across the zonal railways.

Northern railway operates in the geographical area between Baramula in the north to Bhildi in the west and Varanasi in the east. In terms of output growth, Northern railway was second among the zonal railways during the first period. However, the output performance exhibited a declining trend over the years. Other performance indicators also exhibited similar trends. Overall composite index during the first phase of the study ranks Northern railway at 5th position among the zonal

Table 15: Ranking of zones in terms of productivity Performance

Productivity indicators	Periods	Central	Eastern	Northern	N. Eastern	N.E. Frontier	Southern	S. Central	S. Eastern	Western
Output Gr.	1966-76	4	9	5	7	6	8	1	5	3
	1976-91	2	8	3	6	9	7	1	4	5
	1991-99	4	6	7	1	9	3	5	2	8
Labour Prdy	1966-76	2	9	4	5	6	7	1	8	3
	1976-91	3	8	1	7	6	9	2	4	5
	1991-99	4	6	8	1	9	2	7	3	5
Capital Prdy	1966-76	6	8	3	2	1	7	4	9	5
	1976-91	2	8	4	9	5	3	7	1	6
	1991-99	3	6	7	2	9	4	8	1	5
Fuel Prdy	1966-76	2	8	4	9	1	7	6	3	5
	1976-91	5	7	3	9	8	1	4	6	2
	1991-99	2	8	4	1	9	3	6	7	5
TFP Growth	1966-76	5	8	4	7	1	9	2	6	3
	1976-91	2	9	6	7	5	4	8	1	3
	1991-99	2	6	8	1	9	3	7	4	5
First Phase	1966-76	**3**	**9**	**5**	**6**	**2**	**8**	**1**	**7**	**4**
Second Phase	1976-91	**1**	**9**	**3**	**8**	**7**	**6**	**5**	**2**	**4**
Third Phase	1991-99	**2**	**6**	**7**	**1**	**9**	**3**	**8**	**4**	**5**
Overall Performance	1966-99	**1**	**9**	**7**	**2**	**8**	**4**	**6**	**3**	**5**

railways. During the second period, its position improved to 3rd position. However, during the third period of the study, we notice considerable deterioration in its relative position as it declined to 7th rank among the zonal railways. Productivity performance for the entire period was found at 7th position among zonal railways.

North Eastern railway operates in the geographical area between Mathura in the west, Moradabad in the north, Saharsa in the east and Allahabad in the south. It operates mainly in the northern part of UP and Bihar. Productivity in this zonal railway was found very low in terms of most of the indicators during the first two periods. However, a major turnaround occurred in this zone during the last period of the study. From a relatively low rank of 6th position during the first period and 8th position during the second period, North Eastern railway captured number one rank during the third phase in terms of the composite index. For the entire study period, as a result of the poor performance during the first two periods, the overall rank was found at 2nd among the zonal railways.

North East Frontier railway operates between Saharsa in the west, Malda in the south, Tinsukia in the North and Agartala in the South. This zonal railway was one among the best performing zones during the first period. However, its performance deteriorated in terms of most of the performance indicators over the years. During the second period, we notice that North East Frontier railway declined from 2nd position in the first period to 7th position during the second period. During the third period, it further deteriorated to last position. Overall ranking in terms of composite index for the entire period places this zonal railway 8th among nine zones.

Southern railway operates in the area lying south of Hubli, Dharmavaram, Renigunta and Guntur. This zonal railway improved its performance during the study period in terms of most of the performance indicators. During the first period, Southern railway ranked 8th among the zonal railways in terms of productivity performance. During the second period, it improved its position to 6th rank and during the third period, improved further to 3rd position in terms of the composite productivity performance. For the entire period, Southern railway ranks 4th among the zonal railways.

South Central railway operates in the geographical area between Khandwa in the north, Marmagoa Harbour in the west, Tirupati in the south and Visakhapatnam in the east. This zonal railway exhibited considerable deterioration in productivity performance during the study. During the first period of the study, South Central railway was found as the number one ranking zonal railway. However, we find rapid deterioration in the second and third periods as it declined to 5th

and 8th positions respectively. Overall ranking places South Central railway at 6th among the zonal railways.

South Eastern railway operates in the geographical area between Nagpur in the west, Chandrapura in the North, Bagachhiya in the east and Visakhapatnam in the south. This zonal railway operates mainly in the eastern mining belt of India. During the first period of the study, it ranked 7th among the zonal railways. However, in the second period, the productivity performance considerably improved and this zonal railway stood second among the zonal railways in terms of composite performance indicators. During the third period, we notice a decline in its performance to 4th rank. For the entire study period, South Eastern zonal railway stood at 3rd position in terms of composite productivity indicators.

Western railway operates between Rewari in the north, Dwarka in the west, Mumbai central in the south and Bhopal in the east. During the first and second periods, Western railway stood at 4th position in terms of composite productivity indicators (Table 15). During the third period of the study, it marginally declined to 5th position. For the entire study period, Western railway reported 5th rank among the zonal railways in terms of the composite productivity indicators.

Summary

In this paper we have analysed the performance of zonal railways during 1966-67 to 1998-99 in terms of their aggregate output growth, factor input growth, partial productivity growth and total factor productivity growth. Aggregate railway output was found growing at a lower rate than the GDP growth resulting in erosion of railway share in favour of other modes of transport, particularly road transport. Labour force in railways kept on increasing till 1991-92, however, during the later years we notice a secular decline. Nearly 74 thousand employees have been reduced during 1991-99 period. Output growth exhibits a declining trend during the economic liberalisation period as compared to earlier period.

Employment reduction positively contributed to labour productivity growth. Among the factor inputs, only capital input shows considerable increase over the years. Fuel consumption in terms of coal replacement units remained more or less the same over the years. Output growth coupled with stagnant labour and fuel inputs resulted in improving partial productivity ratios of labour and fuel. However, in the case of capital, we notice decreasing productivity ratios for most of the zonal railways over the years.

Employment reduction positively contributed to labour productivity growth.

Total Factor productivity analysis for the first period (1966-67 to 1975-76) exhibited negative growth at all India level. At the zonal level, four zonal railways, namely Eastern, North Eastern, Southern and South Eastern exhibited negative TFP growth. During the second period (1975-76 to 1990-91), TFP growth exhibited considerable improvement across all the zonal railways. The overall TFP growth during this period reported at 2.45 per cent per annum. During the third period (1990-91 to 1998-99), all zones with the exception of North Eastern Frontier railways exhibited positive TFP growth; however, the overall TFP growth was found lower than the previous period. This period corresponds to economic liberalisation phase of Indian economy. The impact of liberalisation on the performance of various zonal railways was mixed; in the case of Central, North Eastern and Southern zones, the impact of economic liberalisation on TFP growth was positive; for the other zones, the rate of growth of TFP declined during the liberalisation period.

Relative productivity ranking of zonal railways based on the composite performance indicators varied considerably during the three periods of the study. During the first period (1966-67 to 1975-76), South Central railway ranked first in terms of composite ranking while the lowest rank was found at Eastern railway. During the second phase, Central railway ranked first and again Eastern railway ranked the last in terms of composite performance indicators. During the third phase, North Eastern railway ranked first and the North East Frontier railway ranked last. Overall ranking for the entire period shows Central railway first and the Eastern railway last. Major factors that contributed to Central zone's success are the overall economic development of this region as compared to other regions. A number of factors such as urbanisation, industrialisation, less extremist activities, political stability etc, positively contributed to better performance of this zonal railway. In the case of Eastern zone, it is primarily due to underdevelopment of this region coupled with criminal attacks

Major factors that contributed to Central zone's success are the overall economic development of this region, urbanisation, industrialisation, less extremist activities and political stability.

on passenger and freight traffic and ticketless travel etc. North East Frontier Railway was performing well during the first phase of the study. However due to political upheavals and the related militancy of the region, both passenger and freight traffic got badly affected. This points to the fact that both economic and political factors are equally responsible for the relative performance of the zonal railways. It may be noted that a stable political climate is a pre-condition for better zonal railway performance and economic development of the region.

Eventhough various restructuring schemes have been initiated in the recent years to improve the efficiency of Indian railways, the impact of these initiatives hardly get reflected in the overall performance of the system.

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You can look at product innovation, operational excellence, everything. But the real competitive advantage comes down to people and earning their trust every day.

– Bill Hamman

Feature

Plastic Waste Management Options in India: An Environmental Evaluation

Sabah Khan

With rapid growth in the use of plastic products in the last two decades, there has been a tremendous increase in the generation of domestic, urban and industrial polymeric waste, which if not properly managed can cause health and environmental hazards. This has led to numerous campaigns against the use of plastic products by the so-called environmentalists. Polymeric wastes are both legacies and current by-products of many industrial units. Plastics do not put a toll on the natural resources since they are synthesized artificially, thus their disposal should be properly managed to make them the most environmentally friendly materials. The paper figures out the position of India as generator of plastic waste among the world's other countries, and in keeping with ISO 14001 and CPSC some techniques are put forward for management of plastic waste products.

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Worldwide production of plastic materials has increased from less than 5 million tons in the 1950s to about 90 million tons in 2001. The plastic industry in India is about forty years old, starting with two tiny plants of Calico and Shriram, set up to produce PVC using indigenous raw materials. The setting up of IPCL in Baroda during 1970's to produce LDPE and PVC was a milestone in the growth of plastic industry in our country. Subsequently, the industry got a fillip with the setting up of Reliance Industries Limited and expansion of IPCL. Today, the plastics industry produces around for million tonnes of different types of plastic resins. The per capita consumption of plastics in India is presented in Table 1.

Table 1: Per Capita Consumption of Plastics in India in the Last Two Decades

Year	Per Capita Consumption
1980-1985	0. 6 kg
2000-2004	3.5 kg
2005-2006	6.0 kg

Consumption of virgin plastic in India is expected to be in the range of 5 to 6 million tons by the year 2002 and the waste generated will be about 2 million tons annually, e.g. the quantity of plastic wastes generated in Delhi is estimated to be 300 mt per day in the White paper On Delhi Pollution (GOI, 1997). The problem pertaining to the management of plastic wastes in its non-biodegradability. The plastic waste reprocessed is about 1,000 mt per day, a substantial amount of which comes from sources outside Delhi. Fig. 1 presents the zonal distribution of plastic waste in India.

The problem pertaining to the management of plastic wastes in its non-biodegradability.

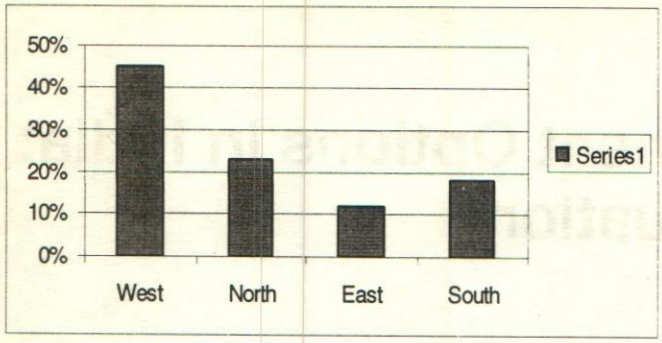

Fig. 1. Zonal Distribution of Plastic Waste in India

A recent study by Britain's Environment Commission entitled The Environment Industry: A Global Perspective, estimates the Indian market for clean-up technologies will be US $2 billion by the turn of the century and US $7 billion by 2010. Indian cities and towns generate about 80,000 metric tons of municipal solid wastes everyday and it is estimated that about 25 million tons of such wastes is generated annually. For every ton of waste we produce in our homes, it is estimated that 5 tons of waste has already been created at the manufacturing stage, and 20 tons at the point where the raw material was extracted. However, on an average, only 60 per cent of solid waste is collected in urban areas leaving the balance 40 per cent of the urban wastes unattended. This gives rise to insanitary conditions and diseases, especially among the urban poor who constitute 40 per cent of urban population. On average every person in India throws away his own body weight in rubbish in every two months.

Solid Waste Categorization

The government has declared that there are six kinds of waste: construction/demolition, hazardous, special, industrial/residual, municipal, and universal. With this list you begin to see that tossing all waste into one waste bucket isn't possible. Construction and demolition waste includes bricks, concrete, roofing materials, framing lumber, cement blocks, dirt and similar materials associated with construction. Municipal waste includes such innocuous materials as your lunch bag, the little packet of potato chips, the wrapper from pills, cloth, paper, beat up old pieces of wood, and so on. Industrial or residual waste includes waste from industrial processes that isn't a product or co-product: mill wastes, wood wastes, greases and waste water. Universal wastes include fluorescent lamps, mercury-containing switches and thermometers, sodium lamps, NiCad batteries and unused pesticides and herbicides.

Hazardous waste includes a collection of items harmful to people and the environment. There are two kinds of hazardous wastes:

Characteristic hazardous wastes:

- Ignitable waste (which have a flashpoint under 140 degrees Fahrenheit)
- Corrosive waste (chemicals that eat their way through containers and skin if you get it on yourself).
- Reactive wastes (which explode or react violently with water or generate toxic gases).
- Toxic wastes (which can poison groundwater and streams).

Listed hazardous wastes:

- Includes a special set of materials such as PCBs (polychlorinated biphenyls) and PCB-containing oils, asbestos, hospital wastes that have to be disposed of by burning by and at approved facilities.

National analysis of household waste

There are significant differences is the composition of household waste over the years, which can be traced to fundamental social and economic shifts affecting the way we live our everyday lives, as is traced in the chronology. Waste can be difficult to quantify, and it is only over the last few decades that there has been any real attempts at estimating the compositions of household waste (Fig. 2). In the 1930s the average dustbin was 0.05 cubic meters in size. Today the average dustbin is 0.09 cubic meters in size.

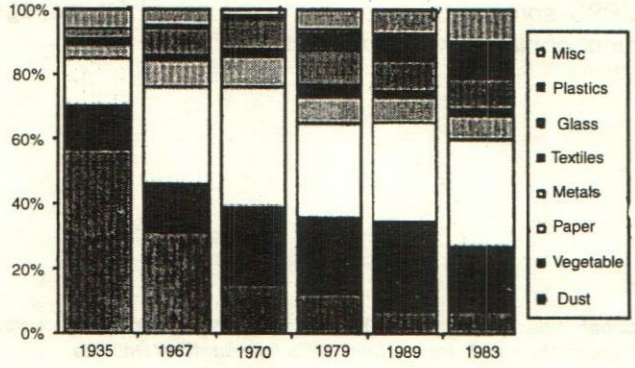

Fig. 2. Composition of household waste

Potentially 50 per cent by weight of dustbin contents is recyclable. Another 20 per cent are made up of compostable organic material. On average only 5 per cent of dustbin contents is recycled despite the fact that surveys show that over 90 percent of people think that recycling is important. This means that we could recycle ten times

as much as we do now. By contrast 83 per cent of household waste is land filled, 3 per cent is land filled with energy recovery, 7 per cent is incinerated, 2 per cent is incinerated with energy recovery. In comparison, Switzerland only landfills 20 per cent, Japan and Denmark 30 per cent, France and Belgium 35 per cent, Italy and Germany 65 per cent (Report on Survey and Assessment of Plastic Waste in India by NPC, 1998).

Potentially 50 per cent of dustbin contents is recyclable. Only 5 per cent is recycled.

There are growing amounts of relatively new waste, not only white goods such as refrigerators and cookers, but electronic goods such as computers. The rapid increase in the consumption of electronic goods, many of which have a built in obsolescence, has resulted in vast quantities of potentially valuable materials going to landfill. Medical products made of plastics are being increasingly used in the healthcare establishments as they not only reduce the transmission of infection but also cost less when compared to other materials. Plastics comprise around 15 per cent of the total medical wastes generated in a hospital (P. Ram Kumar, 2001).

Plastic Waste Management Options

We need to look at ways in which we can reduce the amount of waste we create, for instance by thinking about the amount of packaging we buy and shopping for durability. We can also easily re-use many products such as plastic bags and envelopes. There are many re-use schemes now set up, such as children's scrap stores, and schemes to pass on unwanted household or office items to community or voluntary groups. What cannot be eliminated or re-used should then be recycled where possible. The following are the options for dealing with waste.

We need to look at ways in which we can reduce the amount of waste we create.

- Waste-reduction
- Re-use of materials
- Recycling and composting
- Incineration with energy recovery
- Landfill
- Disposal without energy recovery

Recycling has many environment advantages: it uses less energy causing less pollution; it reduces the demand for virgin resources; it reduces the amount of waste landfilled. However energy is still used in the process and it cannot completely replace the need for raw materials. The best situation would be not to create so much waste in the first place. The process of recycling basically involves the following steps: splitting into smaller pieces, grinding into chips by a grinder, cleaning or washing, sun drying or electric drying, extrusion, cooling, granulating i.e. the extruded wires are cut into grains of the required size, packing and dispatching.

Currently most plastic recycling in India is of 'process scrap' from industry. This is easy to recycle, as there is a regular and reliable source, uncontaminated by previous use. Post-use plastic is defined as "plastic material arising from products, which have undergone a full service life prior to being reclaimed." This plastic waste requires collecting, sorting and in most cases cleaning and is therefore harder to recycle, however this type of recycling is on the increase.

Table 2: Estimates of post-use recycled plastics

Polymer Type	Tonnes
Polyethylene (PE) film	54,000
Polypropylene	19,000
Polyethylene	9,000
Polystyrene	5,000
Expanded polystyrene	7,000
A.B.S.	3,000
Acrylic	1,200
Bottles domestic source	4,300
PVC	10,000
Total	112,500

Data supplied by RECOUP

Table 2 presents the estimates of post-use recycled plastics. There has been an increase of about 7,000 tonnes (10.7 per cent) over the 1994 total. This is almost entirely due to an increase in post-use polyethylene film recycled. According to RECOUP (Recycling Of Used Plastics containers), 108 million plastic containers (mainly plastic bottles), equivalent to 5,500 tonnes, were recovered from household waste in 1996. One third of local authorities now have plastic bottle recycling schemes, and the number is growing. About 95 per cent

of plastic bottles in household waste are made from PE, PVC or PET. 60-80 per cent of plastic waste is recycled in India, which equates to more than 1,000 tons of plastic waste being re-processed daily. 60 per cent of the 18,000-odd plastic units in the country are unregistered. 60 per cent of the unregistered units are located in residential areas and engaged either in conversion of plastics scrap or trash into plastic grains or these grains into products like carry bags, cheap toys, ball pens, medicine bottles and other plastic goods. There has been a 60 per cent increase in the number of illegal re-cycling units in the last five years.

A US Environmental Protection Agency (EPA) study reported that approximately 10 per cent of the weight content at all municipal landfills is plastic waste, which equates to millions of pounds of plastic being added to the environment each year. IBM has instituted Worldwide Materials Recovery Centers, which process millions of pounds of plastic waste. Last year, the Society of Plastics Engineers awarded IBM "Recycler of the Year" recognition. IBM claims that its desktops represent the world's first PCs made from 100 per cent recycled plastic resin for all major plastic parts. The computers' central processing unit (CPU), contains what was once three and a half pounds of plastic material. One of the eight parts that IBM is building with recycled materials is now 20 per cent less expensive to manufacture than when it was made using new plastics (Matt Hines, 1999).

Biodegradable plastics, which contain a small percentage of non oil-based material, such as cornstarch, and photodegradable plastics, have a role in reducing waste and limiting the possible dangers of plastic litter. Carriers for packs of beer cans are now being manufactured in a plastic, which photo-degrades in six weeks. The ability of plastics to degrade is dependent on conditions, for instance a photodegradable plastic product will not degrade if it is buried in a landfill site where there is no light. Another concern is that these materials may lead to an increase in litter if people believe that discarded plastics will simply disappear. The Central Tuber Crops Research Institute (CTCRI) has developed a starch-based, biodegradable plastic, which disintegrates into the soil within six months. The technology has already been transferred to a Delhi-based company and commercial production is expected to start within three months.

According to research, filling, grafting or blending starch with synthetic polymers imparts biodegradability to the fabricated plastic goods. The formulation contains up to 40 per cent starch and an appropriate amount of suitable gelatinizing, plasticizing and coupling agents, which can be blown into film. The starch-based plastic film possesses adequate mechanical strength and flexibility to make it suitable for various agricultural applications. The biodegradable plastic, which is not recyclable, will be 15-20 per cent more expensive than conventional plastic because of the higher cost of raw material. According to CTCRI, once mass production of the plastic starts, the government may consider a phased ban on non-biodegradable plastics. At present, the main challenge for the product is to get acceptance among manufacturers and end users. Vegetable vendors mainly use recycled bags. If they buy the new product they will have to pay more to provide free packages to the customers. But product cost should come down once mass production begins (Business News Archives Bulletin, 1999).

Feedstock recycling describes a range of plastics recovery techniques, which break polymers down into their constituent monomers, which in turn can be used again in refineries or petrochemical and chemical production. Ranges of feedstock recycling technologies are currently being explored and include pyrolysis, hydrogenation, gasification and thermal cracking. A pilot plant has been set up in Bombay for conversion of garbage into energy pellets. It is proposed to set up ten more such plants for which external assistance is likely to be sought. The process of anaerobic digestion/biogas generation from garbage is being utilized at medium and small-scale levels at several places in India, and is being encouraged at other places also. Conversion of garbage into compost by vermiculture and other processes is also being promoted. All these processes not only help in waste utilization but also in producing energy or products of utility.

A pilot plant has been set up in Bombay for conversion of garbage into energy pellets.

Incineration represents a treatment for the destruction, safe transformation, or reduction of waste into inert residue by high temperature combustion. It consists of various combustion techniques where plastics alone or mixed with other wastes are burnt with or without heat and power recovery. This process is capable of reducing the weight of refuse by 80 per cent and the volume by 90 per cent. The residue from the refuse is inert and may be disposed of in a landfill. When the process is used for recovery the product can be used as fuel, e.g. in China the product obtained from combustion of polyethylene items is being used as an automobile fuel. The procedure is still under test but has given positive results. This process is an environmentally acceptable method of plas-

tic waste disposal with minimum air pollution and maximum heat recovery. Countries like U.S.A., Belgium, U.K., Japan, Sweden, and Switzerland are using this technique since the early 1980's for electricity generation. India is yet to catch up with these countries, since one or two attempts made to use this method failed due to hindrance of the recyclers and ignorance of the proper working of incinerators by the people associated with them. For best results from the process of incineration, all the recyclable elements for which there are markets are to be removed first; organic waste removed and composted separately and potentially hazardous materials, such as batteries, removed. Incinerators should be built to meet the highest possible standard, with strict emission controls to avoid air pollution.

In China the product obtained from combustion of polyethylene items is used as an automobile fuel. This process is an environmentally acceptable method of plastic waste disposal.

Another disposal technique for polymeric waste is burial. A landfill site may be viewed as a biological reactor in which some of the waste decomposes over time. Time, temperature and the moisture content play an important role in degradation of waste into lower molecular weight liquids, solids or gases. Plastics decompose because of the combined action of oxidation, hydrolysis, stress cracking and attack by micro-organisms, insects and rodents. This process has been prevalent in the US since a very long time where about 85 per cent of waste is landfilled, however in India it is yet to become popular since land is the most important natural commodity whose demand is continuously increasing with the increasing population.

Every day 50 million food and drinks cans end up as rubbish in holes in the ground. Despite the prediction that it will take over one million years for a glass bottle to degrade, every day over 14 million glass bottles and jars end up as rubbish. Despite the prediction that it will take around 450 years for a plastic bottle to degrade, we use more plastic (PET) bottles per capita in India while our recycling rate for bottles is only about 4 per cent.

Steps by Indian Government

Indian Government is initiating governmental policies and conducting conferences and seminars, where experts on waste management hold discussions on possible options. The central government presented the following draft rules as a possible solution for the disposal of plastic carry bags:

Draft Rules presented by the Central Government in the Gazette of India (No. 786)

1. Short Title—These rules may be called Re-cycled Plastics Usage Rules, 1998.
2. Prohibition of usage of carry bags made of re-cycled plastics.
3. Condition of usage of carry bags etc.—Subject to the provisions of rule 2, any person may use carry bags or containers made of re-cycled plastics if the following conditions are satisfied, namely:
   - Carry bags and containers made of recycled plastics conform to the specifications mentioned in the Prevention of Food and Adulteration Act, 1954 and the rules made there under;
   - Such carry bags and containers are not pigmented:
   - The minimum thickness of carry bags made of recycled plastics shall not be less than 25 microns; and
   - Reprocessing or recycling of plastics is undertaken strictly in accordance with the Indian Standards, IS 14534: 1998 entitled "Guidelines for Recycling of Plastics" published by the Bureau of Indian Standards and the end product made out of recycled plastics is marked as "recycled" alongwith the indication of the percentage of use of recycled material.
4. The minimum thickness of carry bags made of virgin plastic shall not be less than 20 microns.

Although these rules were drafted about three years ago we are still unable to implement them on a large scale.

The National Task Force on Plastic Waste Management, constituted by the Ministry of Environment and Forests, has made recommendations which lay emphasis on raising consumer and public awareness, upgrading methodology of waste collection and segregation, recycling and reprocessing systems and promoting end-product applications with desired recyclable component based on Guidelines for Recycling of Plastics issued by the Bureau of Indian Standards. Committee on Solid Waste Management suggests Constitution of a Technology Mission to oversee waste disposal.

Following Supreme Court directions in a public interest Writ Petition No. 888 of 1996, an eight-member Committee on Solid Waste Management headed by Shri Asim Barman, Municipal Commissioner, Calcutta Municipal Corporation has submitted its final report to the Supreme Court and the Ministry of Urban Development. The Report which came up for further consideration by the Supreme Court on April 13, 1999 states that:

"In Class-I Cities of India simple technologies and easily achievable standards with liberal timeframe knowing the limitation of urban local bodies and their institutional capability will raise the standards to reach higher level of services. The Committee has also suggested minimum standards for the local bodies, in consultation with the Central Pollution Control Board for disposal of wastes. The timeframe recommended for an efficient solid waste management, is three years. The Committee has suggested amendments in State Laws needed to make solid waste management practices effective."

Solid Waste Management Projects

The Housing and Urban Development Corporation (HUDCO) has sanctioned seven solid waste management projects at a cost of Rs. 4176 lakhs. Out of this, the loan component by HUDCO is Rs. 2696.92 lakhs. These projects are, solid waste management for the twin cities of Hyderabad and Sikendrabad, Solid Waste Management Scheme for Cochin and Calicut, bio conversion of municipal garbage of Vijayawara, demonstration of comprehensive solid waste management system at Panaji, solid waste and sewer management for Rajkot and management of solid waste including hospital waste of Varanasi at Rs. 715.2 lakhs. Besides, HUDCO is also working on the following projects. The Ministry of Agriculture is encouraging the utilization of waste to produce compost by providing subsidies of one-third the project cost (limited to Rs. 5 million) for setting up of compost plants in urban areas. Hudco provides financial support to entrepreneurs and industries that come forward to take up such projects. The compost plant financed to Calicut Municipal Corporation is an example of public-private partnership with the municipality owning the plant, Excel Industries providing technical know-how and a private operator operating it. The Ministry of Non-Conventional Energy Sources is providing capital subsidy equivalent to 50 per cent of equity stake (limited to Rs. 10 million) per MW for waste-to-power generation projects. Hudco has sanctioned a loan of Rs. 48 crores (US $12 million) for solid waste management in Varanasi, which generates 600 tons of garbage per day. Hudco is also financing projects with biomethanation of municipal waste and power production plants at Nagpur and Pimpri- Chinchwad; solid waste management at Shillong in Meghalaya, Imphal, Kohima and Dimapur in Nagaland, Anandpur Saheb in Punjab, Bharatpur in Rajasthan, Cuttack and Behrampur in Orissa and Kollam, Gururvayur, Thrissur in Kerala.

Conclusion

With so many categories of waste to account for, every common Indian should be made aware of the disposal techniques of plastic waste through government programmes for waste segregation. This is a process that some conscientious city folks go through when they separate their glass bottles, plastic containers, metal cans, newspapers, magazines, cardboard and steel. It is quite obvious from the above classification that plastic products are a major part of all the above categories. In India, where the sale of superior materials is still extensive, some source separation projects aim to for wet-dry separation. Householders should be given plastic bags or containers free or at low cost and door-to- door collection should be organised. Housewives should be educated on the hazards of plastic materials. Street people or other unemployed persons should be engaged for collection, and given the right to sell the dry wastes. Bangalore has several groups like Clean Environs, Waste Wise (Mythri Foundation) and the Centre for Environmental Education working on such projects. The Bangalore City Corporation has cooperated in allocating space in local parks for composting and vermi-composting. NGO projects for primary collection are in some cases encouraging source separation, for instance, some of the Civil Exnora groups in Madras and Ahmedabad and Rotary clubs in Bombay. Plastic medical wastes can be sold as plastic scrap after they are properly disinfected and crushed. This waste has a lot of value because medical disposables are made of virgin high grade plastic. The plastic medical wastes that are sold as scrap are recycled and thus, the hospitals not only reduce their disposal costs, but also earn from these wastes.

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Feature

Crop Diversification in Punjab

D.K. Grover, Kamal Vatta & Gurpreet Kaur

Due to Green Revolution, the cropping pattern in Punjab state has shifted more in favour of high yielding cereals like paddy and wheat. To explore the possibilities of diversification in the state, comparison among the major crops was done on the basis of their returns and water requirements. Despite the need for diversification there is little scope for any success. Although crops like sugarcane, cotton, sunflower etc., assure comparable returns, substitution of paddy and wheat with these crops will further aggravate the problem of over-exploitation of ground water. There is a need to develop better varieties requiring less water and to discourage cultural practices which hasten downward movement of water table in the state.

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Diversification is an important strategy to stabilize farm income by reducing the risk and uncertainty. However, the introduction of merely a large number of crops in the cropping pattern to achieve diversification may lead to unwanted reduced returns. Accommodation of more rewarding crops in the pattern of diversification stabilizes the income at higher level.

From the point of view of agricultural production, Punjab is a surplus agricultural state and is the biggest source of supply of foodgrains. There has been a large increase in the area under cultivation and the total cropped area over time in Punjab. At the same time, the cropping pattern has also undergone drastic change under the impact of Green Revolution policy. The important point which must be noted here is that the cropping pattern has changed more in favour of cereals like paddy and wheat. In the context of Punjab, diversification presently means substantial shift in the area from paddy and wheat to other crops like fodder, fruits and vegetables. A study was attempted to explain the trends of diversification in the state and to explore future possibilities.

Methodology

The data pertaining to the area under different crops in the state was collected from various issues of Statistical Abstract of Punjab from 1960-61 to 1997-98. Then the percentage of area under different crops to the net cultivated area was calculated. Shifts in cropping pattern were analysed by comparing the percentage of net cultivated area under different crops for different periods of time. Two measures of crop diversification were used viz., Herfindahl Index and Entropy Index. The two measures were compared over time to study the trend of diversification in the state.

Herfindahl Index (H.I.)

$$H.I. = {}_{i=1}{}^{N}\sum P_i^2$$

where N is the total number of crops and P_i represents the acreage proportion of i-th crop in the gross cropped area. The Herfindhl index is bound by zero and one. Actually, it is a measure of concentration. It becomes one with perfect specialization and its value decreases as diversification increases.

Entropy Index (E.I.)

$$E.I. = {}_{i=1}{}^{N}\sum P_i^* \log (1/P_i)$$

This is an inverse measure of concentration. The index increases with increase in diversification and approaches zero when there is a perfect concentration.

To study the future prospects of diversification in the state, economic comparison of paddy and wheat was made with the other alternative crops, so as to select only those crops as alternative, which apart from providing comparable income might decrease water consumption to slow down the depletion of ground water table in the state.

Results & Discussion

Past Experience

Temporal view of the cropping pattern may help in estimating the movement of state agriculture towards diversification or specialisation. Sometimes the composition of cropping pattern may change even without any change in the extent of diversification/specialization. Area under paddy increased from 6.06 per cent in 1960-61 to 54.20 per cent of the net cultivated area during 1997-98 (Table 1). Likewise there was a decline in the area under maize from 8.72 per cent to 3.99 per cent of the net cultivated area, over the same period. However the area under bajra & jowar and groundnut declined over the study period. After a decline from 1960-61 to 1970-71, the per cent area under cotton remained more or less the same. However the per cent area under sugarcane experienced a fluctuating trend. In the rabi season, area under wheat increased from 37.33 per cent to 78.52 per cent of the net cultivated area (from 1960-61 to 1997-98) with a small decline during the nineties. Percentage share of barley, gram, rapeseed & mustard, linseed and lentil also declined sharply over time. With the introduction of sunflower during nineties, the area under the crop increased from 0.12 per cent during 1990-91 to 1.33 per cent during 1997-98.

Thus paddy and wheat are the major crops of kharif and rabi season, respectively with more than 70 per cent of the gross cropped area under them. Cotton and fodder and other crops also occupied a significant area, the share of all the other crops in the cropping pattern of the state was negligible, which has declined considerably from 1960-61 till now. Thus, it may be concluded that monoculture is being practiced in the state with dominance of paddy and wheat in the cropping pattern.

Monoculture is being practiced in the state with dominance of paddy and wheat in the cropping pattern.

Table 1: Shifts in the cropping pattern of Punjab, 1960-61 to 1997-98

Crop	1960-61	1970-71	1980-81	1990-91	1995-96	1997-98
Paddy	6.06	9.62	28.22	47.77	52.21	54.20
Maize	8.72	13.69	7.25	4.34	4.14	3.99
Bajra & jowar	3.43	5.23	1.66	0.28	0.19	0.11
Groundnut	1.78	4.29	1.98	0.27	0.20	0.21
Cotton	11.92	9.79	15.49	16.61	18.13	17.30
Sesamum	0.21	0.36	0.40	0.43	0.56	0.34
Sugarcane	3.55	3.17	1.69	2.38	3.19	3.07
Kharif pulses	0.67	0.81	1.39	1.74	1.64	1.55
Wheat	37.33	56.72	67.10	77.60	79.30	78.52
Barley	1.77	1.41	1.55	0.87	1.06	0.94
Gram	22.35	8.84	6.16	1.42	0.47	0.32
Rapeseed & mustard	2.85	2.54	3.24	1.64	2.18	1.67
Linseed	0.08	0.07	0.05	0.02	0.02	–
Lentil	0.81	0.32	0.48	0.23	0.13	0.11
Sunflower	–	–	–	0.12	0.88	1.33
Tobacco	–	–	1.66	–	–	–
Potato	0.24	3.03	0.95	0.55	1.21	1.24
Chillies	–	0.42	0.31	0.05	0.15	0.09
Other vegetables	0.01	0.57	0.56	0.73	1.19	2.02
Fruits	1.12	1.23	0.69	1.64	2.03	2.15
Fodders & other crops	23.29	17.97	20.51	19.16	17.46	18.07
Net Cultivated Area ('000 Ha)	3750	4053	4191	4218	4139	4204

Note: Figures in the table represent per cent of the net cultivated area.

Source: Statistical Abstract of Punjab (various issues)

The trend of values of the Herfindahl and entropy indices calculated from 1960-61 to 1997-98 were studied (Table 2). It emerged that there was an increasing trend in the values of Herfindahl index and continuous decline in the value of entropy index from 1960-61 to 1990-91;

Punjab agriculture moved continuously towards specialization till 1990-91. After that period, there was little increase in diversification.

however, very small but opposite change in the values was observed thereafter. The value of Herfindahl index increased continuously from 0.1715 in 1960-61 to 0.2840 in 1990-91 and then decreased slightly to 0.2771 during 1997-98. In the opposite manner, the value of entropy index first declined from 0.8975 (1960-61) to 0.7006 (1990-91) and then slightly increased to 0.7110 during 1997-98. It may be concluded that Punjab agriculture moved continuously towards specialization till 1990-91. However, after that period, there was little increase in diversification. It might be due to a small decline is the proportionate area under wheat and an increase in the area under sunflower after its introduction during the nineties. But the extent of change is not very encouraging and Punjab agriculture still falls under the category of highly specialized agricultural states. It is largely due to the reason that green revolution came largely in terms of paddy and wheat. The introduction of high yielding varieties of these crops during the green revolution period resulted in significant increase in their yields. At the same time, the government also adopted a protective price policy towards these two crops as economy was not self sufficient in foodgrains. Thus, farmers started shifting toward paddy-wheat rotation due to the stability in terms of prices and yields.

Farmers started shifting toward paddy-wheat rotation due to the stability in terms of prices and yields.

Table 2: Trend of Diversification Indices in Punjab, 1960-61 to 1997-98

Index	1960-61	1970-71	1980-81	1990-91	1995-96	1997-98
H.I.	0.1715	0.2074	0.2335	0.2840	0.2792	0.2771
E.I.	0.8975	0.8959	0.8262	0.7006	0.7139	0.7110

Source: Calculated from table-1

Today, society again wants a shift in the cropping pattern in favour of other alternative crops keeping in view the long term adverse effects of paddy-wheat rotation on soil health, water and natural resources of Punjab. The high nutritional requirements of paddy and wheat, the major crop rotation in the state, has exhausted the soil of nutrients. A particular crop enterprise exhausts the soil of specific soil nutrients, for example paddy takes more zinc from the soil. Imbalance in soil nutrients may be caused if farmers continue to raise the same crop year after year on the same piece of land. The puddling of field for paddy has disturbed soil-texture and structure. Application of farm yard manure, compost, green manuring and including leguminous crops in cropping pattern are essential to improve soil health. At present, the water table in the sweet water zone, covering about two-third of the area of the state, has been falling at an annual rate of 0.23 meter and it is feared that the situation will further aggravate if water is used continuously at the existing rate. Also, the raising of a single crop on the entire farm may ruin the farmer due to the destruction of the whole crop during natural calamities.

Thus, it can be inferred that diversification of crops is essential in Punjab to maintain the fertility of the soil, to minimize risk and to maintain ecological and hydrological balances. Only those crops need to be included in the cropping pattern, which apart from providing comparable income may also help in alleviating the problem of erosion of natural resources.

Diversification of crops is essential to maintain soli fertility, to minimize risk and to maintain ecological and hydrological balances.

Future Prospects

The objective of diversification of agriculture in the state can only be achieved if it does not result in marked decline in farm income. It is possible only if paddy and wheat crops are replaced by some other crops which could provide comparable returns over variable costs. Thus, the returns from various crops, in the state, were compared to find the possibility for such replacement (Table 3). The maximum returns during the kharif season were provided by sugarcane (ratoon) followed by American cotton and paddy (sugarcane being an annual crop, was compared with paddy-wheat rotation). These crops provide returns of Rs. 10908, 8850, 5963 over the variable costs, respectively. The maximum returns (over variable costs) in the rabi season were provided by wheat followed by sunflower, the returns over the variable costs provided by wheat were Rs. 5488 and that by sunflower Rs. 4031. Thus, by comparing different kharif and rabi crops, two alternatives i.e. sugarcane and American cotton during kharif and sunflower (which competes with late sown wheat)

Table 3: Economics of Major Crops in Punjab, 1998-99

(Rs./Ha)

Crop	Gross Returns	Variable Costs	Returns over Variable Costs
Kharif			
Paddy	11570	5607	5963
Maize	8862	4786	4076
Moong	6700	3249	3451
American Cotton	14300	5450	8850
Desi Cotton	11925	5112	6812
Sugarcane (Planted)	26100	19190	6910
Sugarcane (Ratoon)	24050	13142	10908
Groundnut	10005	5874	4131
Rabi			
Wheat	10030	4542	5488
Sunflower	9062	5031	4031
Barley	5790	3139	2651
Gram	3376	3530	–154
Sarson	7575	3583	3992

Source: The Comparative Economics of Kharif and Rabi crops, Department of Economics and Sociology, P.A.U., Ludhiana

during rabi were possible. As relative profitability during a particular year is not the sole determinant of the cropping pattern in any region, other factors like risk (both price and yields risk), suitability of agro-climatic conditions to the crops also have bearing on farmer's mind while deciding on putting area under the crop. At the same time, the problem of declining water table in large parts of the state has to be kept in mind while selecting crops for the purpose of diversification. Thus, with the objectives in mind, water requirements of crops providing comparable returns to paddy and wheat as estimated by a multi-disciplinary expert team of agricultural scientists, PAU, Ludhiana, were analysed (Table 4). Water requirements of paddy, cotton, sugarcane and wheat are 73, 65, 180 and 50 cm., respectively; sugarcane requires the highest amount of water i.e. 180 cm. (when compared with paddy-wheat rotation which requires 123 cm. of water) followed by paddy, cotton, maze and wheat. It is evident that sugarcane has been showing a fluctuating trend because of risk factor due to disposal problem faced by the farmers. Thus the possibility of replacement of paddy-wheat rotation with sugarcane is minimal. While considering the other alternative, although cotton provides higher returns as compared to paddy along with less water requirements, yet, there is no possibility of switching over to cotton crop in the whole state, as the soil of all the regions is not suitable for cotton cultivation. In the rabi season sunflower is economically comparable with late sown wheat and not with timely sown wheat but water requirements are relatively higher (50-70 cm). Thus the possibility of shifting the area from paddy and wheat to other alternative crops in the state is very limited. These crops may provide comparable returns, but diversification of agriculture with these crops will further aggravate the problem of over exploitation of water resources in the state. At the same time, there is little hope to get government support for the shift in the area from paddy and wheat. Punjab contributes 40-50 per cent of rice and 60-70 per cent of wheat to the central pool. Any shift in the area away from these crops without any marked increase in the yields may pose a serious threat to the efforts of feeding the large Indian population. To reduce excessive use of water, the current practice of early transplanting of paddy should be avoided. Farmers must be encouraged toward timely transplanting of paddy to save water. Likewise, new varieties consuming less water need to be developed in the long run. □

Table 4: Evapotranspiration Demand for different crops in Punjab

Crop	Evapotranspiration Demand (cm.)
Paddy	73
Cotton	65
Maize	60
Sugarcane	180
Groundnut	50
Wheat	50
Gram	40
Rapeseed & Mustard	35
Sunflower	50-70*
Lentil	40

Source: Prihar *et al,* 1993

* The figure obtained from Deptt. of Agronomy, P.A.U., Ludhiana

New varieties consuming less water need to be developed.

Feature

Prioritization of Rice Productivity Constraints

T.R. Shanmugam & N. Venkatesa Palanichamy

Stepping up rice productivity in Southern India is constrained in a major way by pests, diseases, adverse soils, agronomic and socio economic problems. The authors present a survey of problems confronting rice production in four southern states of India and conclude with a few recommendations.

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Rice is the staple food for most of Indian population and particularly for Southern and Eastern India. There has been a giant leap in rice productivity and production in 80's and 90's after the introduction of high yielding, short duration and photoinsensitive varieties. Increase in the area of rice cultivation, generation of improved rice production technologies and enthusiasm of rice farmers in adopting improved production technologies were the major influencing factors behind the increase in rice production which has matched the demand from growing population.

However, trend in rice production in India over the recent years indicates that the scenario is changing. India, with current population growth rate of 2.1 per cent a year would be the most populous country in the world in 2030. Current growth rate in production does not keep pace with the growth in population. Rice production has come to a stagnation in recent years due to many constraints. With almost no hope for increasing area under rice production, only way out for production increment is to increase the productivity of rice lands in future. The hope to realize higher productivity in rice also seems to be gloomy in the context of yield potential of the present rice varieties reaching a plateau, stagnation in farm yields of rice with everlasting confrontation between farmers and manifold production constraints and limited potentials of available synthetic production technologies in solving the constraints to reach higher yields in rice. A breakthrough in this situation is possible only by a revolution of another kind in rice production by way of increasing biological efficiency of rice varieties as such, possibly through hybrid rice varieties and by unfolding new frontiers of production technologies such as biotechnology and wide hybridization.

Yield gaps

Though the rice yield in India has leveled off in certain regions, it is characterised by low yields in substan-

tial areas. The World Rice Statistics published by IRRI shows that there had been no significant upward trend in yield in many states of India even after introduction of modern varieties and considerable yield variations also exist due to differential levels of adoption of new rice technologies, varying degrees of water control, imbalances in infrastructural development and a host of other factors. The average rice yield per hectare ranges from as low as 2.00 tonnes in Bihar to 5.00 tonnes in Punjab. In a recent study conducted by Tamil Nadu Agricultural University in collaboration with International Rice Research Institute revealed that the average per hectare yield levels of rice varied from 3.2 tonnes to 6.8 tonnes across rice production environments (Tamil Nadu Agricultural University, 1989).

Hence there is a strong case to identify the constraints which keep rice yields significantly below their potential maximum and to channelise efforts to increase yield by solving the constraints particularly in the 'low yield' regions and in the farms with low yield within given regions. The approach should be to identify the nature of yield gap between potential and farm yields, and once the magnitude and nature of yield gap is established, the second aspect is to identify biological, physical and socio-economic factors that explain the above conditions.

There is a quantitative difference between actual and potential production. This difference is called 'yield gap'. Yield gap is not identical for all environments. It is explained by a number of constraints – biological, physical and socio-economic. All these constraints together account for the total yield gap, which could be decomposed into two parts viz., yield gap I and yield gap II. Yield gap I is the difference between an experiment station's maximum yield and an on-farm experiment's maximum yield. This yield gap arises from differences in environment which cannot be managed in the farmer's field. Yield gap II was the primary concern of present study, because, it is the difference between actual farm yield and yield attained in on-farm experiments. This gap reflects biological, soil and water, physiological, genetic and socio-economic constraints.

The difference between actual farm yield and yield attained in on-farm experiments reflects biological, physiological, genetic and socio-economic constraints.

The purpose of present study is to quantify the contribution of each major constraint to the yield gap or production loss and estimate the benefits that might accrue by overcoming the constraints.

Major Constraints

Rice is a highly adaptable plant that is grown under different ecological conditions in sub-tropical and tropical regions. Accordingly, rice production constraints are more in number. Initially, the major constraints in rice production and their magnitude of severity were identified. With the completion of the initial survey, several aspects of different constraints in Southern India become clear. Thus, 43 constraints which have economic significance were identified (Table 1). One striking observation was the consistency of constraint ratings for a given rice environment in the states of Southern India by scientists and extension personnel. Obviously, there are idiosyncrasies or special cases across the regions, but the major constraints were quite uniform. In addition, it was observed that across rice environments, while the major constraints (i.e. insects, diseases, agronomic, physiological and breeding problems) were similar in two states, the minor constraints often differed quite dramatically. Thus, there is a common set of major constraints and variety of minor constraints for each state. Because of this, it would serve little purpose to describe in detail the nature of constraints for each environment in each state, since there is a considerable overlap. Rather the findings of the first phase are presented by describing generally the major and minor constraints identified in different rice production environments.

The respondents, 120 scientists engaged in rice research and equal number of extension personnel, provided estimates of yield loss due to each constraint for their respective agro-climatic zones. However, this does not mean that all these constraints are major and occur simultaneously. These may occur in most severe form in any one of the regions in one of the seasons. The yield loss indicated by them is when the constraint is occuring beyond economic threshold level and is atleast moderately severe. Hence, it would not be realistic to give equal consideration to all constraints. These estimates of yield losses were used to create Tables 2, 3 and 4 which show where these constraints are important. Ranking of top ten rice yield constraints according to production loss for Southern states is given in Table 5. Since the rankings were ordinal, it was not possible to compare the severity of constraints when the relative ranking across the states changed. Thus, the identification procedure indicated whether a constraint was major in a particular state or production environment. Only constraints causing major production losses are discussed for the four states surveyed.

Table 1: Major rice productivity constraints

A. Technical Constraints	
Pests	**Diseases**
Yellow stem borer	Rice blast
Brown plant hopper	Sheath blight
Green leaf hopper	Brown spot
Thrips	Sheath rot
Gall midge	RTV
Leaf folder	Grain discoloration
Ear head bug	Bacterial leaf blight
Rodents	**Agronomical and others**
Cut worm	Imb use of fertilizers
Case worm	Weeds
Coorg caterpillar	Water management
Rice hispa	Aged seedlings
Adverse soils	Lodging
Low fertility	Drought
Acid soils	Cold at anthesis
Salinity	Low light intensity
Alkalinity	Varietal problem
Iron deficiency	
Zinc deficiency	
Iron toxicity	
B. Socio-Economic Constraints	
Labour scarcity	
High cost of fertilizers	
High cost of plant protection chemicals	
Low paddy prices	
Poor technical extension	
Inadequate supply of quality seeds	
Lack of credit	
Shortage of power	
Production Loss	

Andhra Pradesh

In Andhra Pradesh, six agro-climatic regions were selected for the purpose of constraint analysis. Total production of rice in the state was 10.56 million tonnes. Total losses due to all constraints worked out to 2.06 million tonnes, which is 20 per cent of total production. There exists a 20 per cent potential to increase the productivity of rice. Total losses in absolute terms is highest in Andhra Pradesh, since this state leads in production also. Monetary value of these losses worked out to about Rs. 8 million annually. Of these total losses, insects, diseases, adverse soils, agronomic and socio economic constraints contributed 37.13, 23.14, 10.27, 22.19 and 7.27 per cent respectively. Leaf folder tops the list of damages by causing maximum yield loss accounting for about 7.73 per cent of total losses. The other insects in the order are ear head bug, yellow stem borer, brown plant hopper and gall midge ranking second, third, seventh and tenth respectively. Among diseases, blast is the major problem causing about 5.12 per cent of total losses and it ranks fifth in the list. Salinity is an important adverse soil constraint contributing about 4.32 per cent to the total losses. Of the agronomic constraints, lodging, weeds and water management are the major constraints causing yield loss of about 5.18, 4.56 and 4.26 per cent respectively.

Table 2: Production Loss Due to Pests and Diseases

(000 tonnes)

Constraints	Andhra Pradesh	Karna-taka	Kerala	Tamil Nadu	South India
Pests					
Yellow stem borer	120.18	39.39	17.71	61.02	238.30
Brown plant hopper	89.19	29.99	13.76	38.54	171.48
Green leaf hopper	74.49	23.25	13.00	32.07	142.81
Thrips	55.64	25.13	13.14	45.10	139.01
Gall midge	84.07	29.70	16.64	60.47	190.88
Leaf folder	159.13	37.44	20.24	114.42	331.23
Ear head bug	130.52	34.04	16.85	89.89	265.30
Rodents	51.45	25.05	11.68	31.56	119.74
Cut worm	–	–	–	–	–
Case worm	6.54	–	2.04	–	8.58
Coorg caterpillar	–	12.69	–	–	12.69
Rice hispa	3.36	–	–	–	3.36
Sub total	774.57	256.68	125.06	473.07	1623.38
Diseases					
Rice blast	105.15	40.77	16.72	65.68	228.32
Sheath blight	67.75	22.36	16.43	32.88	139.42
Brown spot	61.13	26.48	14.11	41.02	142.74
Sheath rot	62.17	23.12	15.07	31.90	132.26
RTV	57.44	25.70	13.48	35.59	131.58
Grain discolor	42.50	25.07	13.04	31.83	113.07
Bacterial leaf blight	70.00	22.87	12.75	36.84	142.46
Sub total	466.14	186.37	101.60	275.74	1029.85

Karnataka

Total rice production of Karnataka was about 2.41 million tonnes. Of these, production loss due to all constraints worked out to 0.91 million tonnes accounting for 37 per cent of total production. In Karnataka, eight agro-climatic zones were considered for the present constraint analysis. Insects, diseases, adverse soils, agronomic and socio economic constraints contributed 28.12, 20.43, 10.78, 24.10 and 16.57 per cent respectively. Among insects, yellow stem borer, leaf folder, ear head bug and brown plant hopper are major pests sharing about 4.32, 4.10, 3.73 and 3.29 per cent of loss respectively. Rice blast is the major disease causing maximum economic

damage in Karnataka. It ranks first and accounts for about 4.47 per cent of total loss. Zinc deficiency is a common adverse soil problem and losses are worked out to 3.42 per cent of total loss. Among agronomic constraints, imbalanced use of fertilizers, weeds and water management are the important problems contributing to yield loss of 3.90, 3.70 and 3.59 per cent respectively.

Table 3: Production Loss Due to Soil and Agronomical Problems

(000 tonnes)

Constraints	Andhra Pradesh	Karna-taka	Kerala	Tamil Nadu	South India
Adverse soils					
Low fertility	63.45	24.60	10.09	51.50	149.64
Acid soils	–	12.98	15.12	14.44	42.54
Salinity	88.84	29.66	15.24	39.76	173.90
Alkalinity	–	–	–	22.20	22.20
Iron deficiency	–	–	–	10.31	10.31
Zn deficiency	58.78	31.10	–	45.55	135.43
Iron toxicity	–	–	9.10	–	9.10
Sub total	211.07	98.34	49.55	183.76	542.72
Agronomical and others					
Imb use of fert	74.28	35.64	–	74.29	184.21
Weeds	93.92	33.79	5.71	54.57	187.99
Water management	87.72	32.76	15.75	62.60	198.83
Aged seedlings	25.74	–	–	12.37	38.11
Lodging	106.69	23.27	15.77	50.03	195.76
Drought	68.55	24.52	–	41.32	134.39
Cold at anthesis	–	19.59	–	11.38	30.97
Low light intens	–	15.07	–	5.29	20.36
Varietal problems	–	35.33	15.83	–	51.16
Sub total	456.90	219.97	53.06	311.85	1041.78

Table 4: Production Loss Due to Socio Economic Problems

(000 tonnes)

Constraints	Andhra Pradesh	Karna-taka	Kerala	Tamil Nadu	South India
Socio Economic					
Labour scarcity	47.66	25.02	14.55	31.49	118.72
High cost of fert	21.49	25.86	13.71	17.41	78.47
High cost of PPC	19.13	19.25	11.23	9.83	59.44
Low paddy prices	12.31	17.72	9.26	8.21	47.50
Poor tech extension	13.37	18.81	9.66	13.75	55.59
Inadequate supply of quality seeds	8.36	11.24	5.29	8.04	32.93
Lack of credit	15.28	17.99	8.74	14.48	56.49
Shortage of power	12.13	15.51	7.41	10.99	45.96
Sub total	149.73	151.40	79.85	114.20	495.10

Kerala

All the four agro-climatic zones were considered for the present study. The total losses in Kerala was about 1.01 million tonnes and accounts for about 39 per cent of total production. The relative share of losses to production is highest in this state. Productivity of rice in the state is minimum among surveyed states and there exists a 39 per cent potential to increase productivity of the crop. Insects, diseases, adverse soils, agronomic and socio economic constraints account for about 30.57, 24.84, 12.12, 12.96 and 19.51 per cent respectively. Among pests, leaf folder tops the list followed by stem borer, ear head bug and gall midge sharing total losses of about 4.95, 4.33, 4.12 and 4.01 per cent respectively. Rice blast is major disease in Kerala because of its humid climate. It causes economic losses of about 4.09 per cent. Next to blast, sheath blight is an endemic disease in deep water production environments accounting for about 4.02 per cent of losses. Salinity and acid soils are common adverse soil problems in Kerala because of coastal and hilly tracts and their shares are about 3.73 and 3.70 per cent respectively. Among agronomic and other constraints, varietal degeneration, lodging and water management problems contributed about 3.87, 3.85 and 3.85 per cent of losses respectively. Labour scarcity is the important socio-economic constraint in Kerala accounting for 3.55 per cent of losses.

Labour scarcity is the important socio-economic constraint in Kerala.

Tamil Nadu

In Tamil Nadu, six zones were considered for the present study. Total losses in Tamil Nadu was 1.35 million tonnes, that is, about 24 per cent of production, monetary value working out to Rs. 5.40 million loss annually. There exists 24 per cent potential to increase productivity. Pests, diseases, adverse soils, agronomic and socio economic constraints contributed to production loss by 34.52, 20.38, 13.59, 25.39 and 6.12 per cent respectively. Among pests, leaf folder is the most serious one followed by ear head bug, stem borer and gall midge accounting for about 8.46, 6.20, 4.51 and 4.47 per cent of losses. Rice blast is an endemic disease in Tamil Nadu where relative humidity is high causing about 4.86 per cent of losses. Among adverse soil problems, low fertility is a common phenomenon contributing to the losses about 3.81 per cent. Imbalanced use of fertilizers, water management, weeds and lodging are important

agronomic constraints sharing about 5.49, 4.63, 4.04 and 3.70 per cent of losses.

Summary

Thus stepping up rice productivity in Southern India is constrained in a major way by pests, diseases, adverse soils, agronomic and socio economic problems. Leaf folder tops the list of damages by causing maximum yield loss in Andhra Pradesh, Kerala and Tamil Nadu states indicating urgency for research intervention to contain the damage. It is also one of the major constraints in Karnataka ranking third. Other insects causing major losses are ear head bug, yellow stem borer, brown plant hopper and gall midge. Rice blast is particularly endemic in regions where humidity is high and it ranks first in Karnataka, fourth in Tamil Nadu and Kerala and fifth in Andhra Pradesh. The other disease causing yield loss in deep water regions of Kerala is sheath blight. Scientists have suggested biotechnological interventions to solve yield loss due to pests and diseases more effectively. Lodging is a common constraint in coastal regions of Southern India. Frequent cyclones and floods are responsible for this constraint. It warrants evolving varieties resistant to lodging through widehybridization. Another, rather disturbing aspect of rice production, is that of weed. The problem is very acute in tail end farms where water stress is a common phenomenon. It ranks sixth in Andhra Pradesh, seventh in Karnataka and eighth in Tamil Nadu. Adoption of efficient water management and cultural practices has become crucial for successful control of weeds. Salinity and water management problems are widely prevalent in water logged and coastal zones of Southern India. Both problems are due to poor drainage system and occurrence of cyclones especially in coastal areas. Though drainage facilities were well-conceived and implemented several decades ago, they are not being properly maintained. Large scale encroachments have made drainage channels inoperative. According to scientists, breakthrough in controlling these problems can be achieved by evolving varieties tolerant to salinity through widehybridization and proper water management training to the farmers.

Scientists have suggested biotechnological interventions to solve yield loss due to pests and diseases

Table 5: Ranking of Rice Productivity Constraints by States

Rank	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu
I	Leaf folder	Rice blast	Leaf folder	Leaf folder
II	Ear head bug	Yellow stem borer	Yellow stem borer	Ear head bug
III	Yellow stem borer	Leaf folder	Ear head bug	Imb use of fert
IV	Lodging	Imb use of fert	Rice blast	Rice blast
V	Rice Blast	Varietal prob	Gall midge	Water management
VI	Weeds	Ear hear bug	Sheath blight	Yellow stem borer
VII	Brown plant hopper	Weeds	Varietal prob	Gall midge
VIII	Salinity	Water management	Lodging	Weeds
IX	Water management	Zn deficiency	Water management	Low fertility
X	Gall midge	Brown plant hopper	Salinity	Lodging
XI	GLH	Gall midge	Acid soils	Zn deficiency
XII	Imb. Use of fert	Salinity	Sheath rot	Thrips
XIII	BLB	Brown spot	Brown spot	Drought
XIV	Drought	Grain discolor	BPH	Brown spot
XV	Sheath blight	Thrips	RTV	Salinity

□

If you want to earn more–learn more.

– William J.H. Boetcker

Feature

Pulse Performance in India: A Spatial & Temporal Analysis

I. Sekar & Puran Chand

Pulse production has always been an important component of Indian agriculture. This article presents a study on the growth and trends in the production of pulses in the country. The study highlights the pace of growth and variability in the production of pulses and examines their temporal and spatial performance.

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Pulse crops have remained the mainstay of Indian Agriculture for centuries. Pulses form an essential component of the daily diet of Indians who are predominantly vegetarians. Despite its importance, area (21 to 23 million hectares) and production (10 to 14 million tonnes) of pulses has remained almost static for the past five decades. But on the demand side, population has increased almost three times and as a result, per capita availability of pulses has shown a sharp decline in recent years, coming down to less than 40g per day as against a minimum requirement of 50g per day. This would certainly have a bearing on food security in India. The performance of moongbean production differs not only temporally but also spatially across the states in India.

Objectives

Keeping in view the importance of pulses in Indian diet, the present study is specifically undertaken with the following objectives: To examine the trend of pulse production; to estimate pulse production in future; to examine spatial pattern of pulse production; to analyse yield gaps and production constraints, and to suggest measures for enhancing pulse production in the country.

Data & Methodology

To fulfill the objectives of this paper, secondary data were collected from different published sources, viz. Food and Agricultural Organisation (FAO) production year book, Centre for Monitoring Indian Economy (CMIE). Compound growth rates of area, production and yield were estimated by fitting function of the form,

$$Y = ab^t$$

where; Y = Area/Production/Yield of pulses,

a = intercept

b = regression coefficient of Y on t (time).

The compound growth rate was worked out using following formula:

$$CGR = (b-1)^* 100$$

The inference about existence of acceleration or deceleration within a specified time period is based on the sign of the estimate of "b" in the function. The agricultural growth rate analysis of a crop shows the growth trend in area, production and yield. The trend may be either monotonically positive, negative or constant. A positive growth rate reveals an increase in the related aspect by its magnitude per annum; vice versa is the case for negative trend. In case of a constant trend, there will be no growth at all.

By using the above growth rates for pulse production revealing the past trend, pulse production for the years 2010, 2020, and 2025 A.D were projected.

$$X_t = X_0 \left(\frac{1+cgr}{100}\right)^n$$

where;

X_t = production of x commodity in t^{th} period.

X_0 = production of x commodity in base period ie. 1998

cgr = compound growth rate on the basis of data for the period 1980 to 1998; and

n = number of years considered for projection.

Results & Discussion

Area, production and yield of pulses for a duration of five years were averaged to find out the change of trend in different periods over a span of 25 years (Table 1). The analysis revealed that area, production and yield have undoubtedly increased in the third period (1990-91 to 1994-95) over the first period (1970-71 to 1974-75) but the quantum of increase has not been substantial after 25 years specifically in yield criterion. Magnitude of increase in area of pulses after eighties has been lesser than that before eighties. Though production and yield of pulses increased during the same period, this increase has been quite substantial. Over a period of 25 years, 21.4 per cent yield increase of pulses has been witnessed, which is not remarkable in comparison to increase in yield of cereals. It may have a direct impact on food security, considering the fact of ever increasing population. Research on developing high yielding varieties of pulses needs to be strengthened as little scope lies in horizontal expansion in acreage of pulses.

Area, production and yield have undoubtedly increased but the quantum of increase has not been substantial.

Table 1: Trends in area (000 ha), Production (000 tonnes) and yield (kg/ha) of pulses in India

	Period I 1970-71 to 1974-75	Period II 1980-81 to 1984-85	Period III 1990-91 to 1994-95	% Change in period II over Period I	% Change in period III over period II	% Change in period III over period I
Area	22210.1	22737.1	22996.1	2.3	1.1	3.5
Production	10567.9	11416.4	13303.2	8.0	16.5	25.8
Yield	475.8	502.1	578.5	5.5	15.2	21.4

Table 2: Compound Growth Rates of Area, Production and Yield of pulses (1980 to 1998)

Percent/annum

Crops	Area		Production		Yield	
	World	India	World	India	World	India
Bean	0.23	0.55	1.27	1.66	1.03	1.11
Peas	–0.92	3.37	1.33	5.01	2.27	1.45
Chickpea	0.54	–0.65	1.66	0.91	1.09	1.57
Lentil	2.22	1.31	3.87	3.77	1.51	2.44
Pulses	0.30	0.21	1.36	1.37	1.05	1.16

Area, production and yield of pulses in India showed a positive trend which is evident from Table 2. Among pulses, production of peas has comparatively a better growth rate followed by lentil. The increase in production growth rate of peas in India was primarily attributed to an increase in acreage while as regards lentil it was due to increase in yield. It is obvious from table 2 that the growth rate of area under chick pea decreased in India (–0.65 per cent per annum) and peas at world level (–0.92 per cent per annum) showed a deceleration indicating substitution of area in favour of other competing crops. This substitution could be due to changing food habits. Projection of pulses production (Table 3) showed that chick pea, lentils and beans production in India would be occupying major share in future. Pulse production in India possibly will have almost the same share (about 26 per cent) in world pulse production in years 2010, 2020 and 2025. However, lentil (around 30 per cent) and beans (around 23 per cent) are the possible success stories for future. The share of chick pea may vary from 62 per cent in 2010 to about 56 per cent in 2025. This indicates that pulses would play a

prominent role in future and continue to remain a part of Indian diet as well.

Table 3: Projection of Production of Pulses

'000MT

	World			India		
	2010	2020	2025	2010	2020	2025
Beans	19808	22473	23936	4386 (22.1)	5171 (23.0)	5615 (23.5)
Peas	13950	15920	17008	1330 (9.5)	2169 (13.6)	2769 (16.3)
Chickpea	10755	12679	13767	6689 (62.2)	7323 (57.8)	7662 (55.7)
Lentils	4684	6847	8279	1434 (30.6)	2076 (30.3)	2498 (30.2)
Pulses	66781	76440	81781	17095 (25.5)	19587 (25.6)	20966 (25.6)

(Figures in the parenthesis indicate percentage to the total of World column for the corresponding years)

The trend in pulse production varies widely across states over the years. It is evident from Table 4 that pulse production share has declined in states like Bihar, Haryana, Uttar Pradesh and West Bengal whereas it was found to be increasing in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu. Uttar Pradesh was the major pulse producing state in 1962-65 period with a share of 27.50 per cent but its share declined to 18.54 per cent in 1992-95 period. Over the years Madhya Pradesh has emerged as the major pulse producing state in the country. In 1962-65 Madhya Pradesh had a share of only 14.92 per cent whereas it increased to 24.19 per cent by 1992-95. Orissa's share in pulse production remained more or less the same during these periods. Four states viz. Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh accounted for more than 68 per cent of total pulse production in the country during the period 1992-95.

There is a wide gap in yield of pulses between the actuals and its potentials. This yield gap can be divided into two components viz. Yield gap I and Yield gap II. Yield gap I corresponds to the difference between potential and demonstrated yields and yield gap II corresponds to the difference between demonstrated yield and the actual realized yield. It may be hypothesised as follows: yield gap I is constrained by environmental differences and the yield gap II is caused by biological and socio economic constraints. Biological constraints refer to uncontrollable factors like rainfall, pest and diseases and inherent soil fertility while socio economic constraint refers to the social and economic conditions that prevent farmers from using recommended technology, which may be lack of credit and other input availability, attitude and knowledge level of the farmer, cost and return etc.

Table 4: Spatial disparity of pulse production

(per cent)

States	1962-65	1972-75	1982-85	1992-95
Andhra Pradesh	2.72	3.72	4.54	5.10
Bihar	10.91	7.39	6.41	5.57
Gujarat	1.47	1.23	4.35	4.24
Haryana	4.16	7.82	3.89	3.21
Karnataka	2.93	4.54	4.28	4.52
Madhya Pradesh	14.92	21.96	21.03	24.19
Maharashtra	7.73	8.26	9.15	14.25
Orissa	3.29	4.66	7.92	3.54
Rajasthan	9.36	10.82	12.71	11.17
Uttar Pradesh	27.50	23.28	21.18	18.54
Tamil Nadu	0.91	1.71	1.83	2.52
West Bengal	3.39	3.38	1.77	1.30
All India	100.00	100.00	100.00	100.00

It is obvious from Table 5 that there exists a distinct pattern of yield gap among pulse crops. Yield gap II is greater than yield gap I in all pulse crops. Hence efforts are needed to get rid of biological and socio economic constraints which cause yield gap II.

Table 5: Yield gaps of pulse crops in India (1997-1998)

Crops	Potential yield (t/ha)	Demonstrated yield (t/ha)	Realized yield (t/ha)	Yield gap I (t/ha)	Yield gap II (t/ha)
Chick pea	2.0-2.2	1.5-1.8	0.81	0.45	0.84
Pigeon pea (early)	1.5-1.7	1.2-1.5	0.58	0.25	0.77
Pigeon pea (late)	2.0-2.5	2.0-2.2	0.76	0.15	1.34
Moongbean	1.1-1.2	0.9-1.0	0.29	0.20	0.66
Urdbean	1.0-1.2	0.8-0.9	0.43	0.25	0.42
Field pea	2.0-2.2	1.5-1.8	0.89	0.45	0.76
Lentil	1.5-1.8	1.2-1.4	0.62	0.35	0.68

The constraints confronted in pulse production in India are multifarious. Since pulses are grown largely under rainfed environments, it is highly risk prone. Resource poor farmers are thus forced to take up this venture on their marginal lands. Farmers do not have access to quality seeds of improved varieties. Poor dissemination of modern pulse production and protection

technologies is yet another constraint in pulse production. Hence adoption rate of improved varieties of pulse is quite low.

Conclusions

It is concluded from the study that increase in yield of pulses has been less than one per cent per annum during the study period 1970-71 to 1994-95. Yield increase of pulse has been as low as 1.9 per cent as revealed from data of 25 years (from 1970-'71 to 1994-'95). However by and large, growth rate analysis of pulses from 1980-1998 showed that production of pulses in India has shown a positive trend with better performance in peas and lentil. Chick pea, lentils and beans production in India would have a sizable share in future among the countries world over. Although pulse production in India has a positive trend over the years, per capita availability has been coming down due to increasing population. The study revealed that India would occupy a major share in pulse production among countries across the globe in future. Looking at the future scenario, lesser per capita availability may result in unbalanced diet and impair food security in India. Particularly the poor may get affected more as they can not afford costly protein supplements. Identifying potential cropping pattern with location specific high yielding short duration varieties of pulses which could be fitted in between seasons and getting it popularised would be a better tool for increasing pulse production in India. It is quite possible that recently developed pulse production technologies might not have reached the farmer in a meaningful way. Hence involvement of NGOs besides Government Agricultural Extension personnel to disseminate pulse production technology to farmers might increase the adoption rate and speed. □

Identifying potential cropping pattern, with location specific, high-yielding, short duration varieties of pulses which could be fitted in between seasons, would be a better tool for increasing pulse production.

Alone we can do so little,

Together we can do so much.

– Helen Keller

Feature

Virtual Organisation: A Stratagem

Zillur Rahman

The paper describes how in future the virtual organisations are going to take over the traditional organisations and explain in detail the working of the virtual organisations.

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The corporation of the late twentieth century was just a transitional form. It lasted more than hundred years, but few corporations of that form will remain. Entertainment software production companies, construction project teams and consultant work groups exhibit features that could become prototypes of tomorrow's modern organisations.

The Future of Organisations

In this view of modern organisation, autonomous teams set up as independent contractors or small firms and linked by networks will perform nearly every task. The world would be lonely and unsatisfying for everyone if all interactions were contractual. Therefore, we will have independent organisations for social networking, learning, reputation building, and income smoothing. These organisations will evolve from unions' fraternities, clubs, and churches; many will be similar to the writer's and actor's Guilds of Hollywood. They will help people to save for retirement, and most will pay a percentage of their income to their "guilds" as voluntary form of unemployment insurance.

Big and small companies will exist, but very few will be permanent. Some organisations (backed by long term investors) will focus on long range research and farsighted visioning; others will exploit monetary market opportunities on a second by second basis. Together everything will emerge from the natural activity of the network. Networks exist in temporary combinations for various goals and get dissolved when the goal is achieved. The most successful entrepreneurs will manage, time and again, to be in the right place at the right time, just long enough to broker the deal and be a focal point for resources–quickly, before the game shifts and opportunities pop up elsewhere. Some of the most desirable employees will be fast learners who can manage other fast learners. Everyone in the working world will know the basic skills of new management: how to collaborate, negotiate, broker deals, set up a team, and budgets and meet budgets, facilitate meetings–and, above all, how to use the network effectively.

Social service and charity will be built around the network. We all know that our quality of life is maintained by continuous investments; if we don't keep giving back, we'll all suffer in the end.

Basic skills of new management: how to collaborate, negotiate, broker deals, set up a team, meet budgets, facilitate meetings and use the network effectively.

Consider the design of automobiles: In a typical project, a variety of independent firms form competing coalitions to explore alternative designs for the electronic system, the chassis, or the task of putting the car's subsystems together. Some of these firms may be joint ventures, some may share equity, some may be built around electric markets that control prices and wages. All of them would be autonomous and self organising. They gain their stability from the ubiquitous, high bandwidth, transactions heavy, electronic network that connects them to one another.

Birth of 'e-lancing'—the Linux story

When the kernel of a computer operating system Linux, a rudimentary version of the Unix operating system was made available on the Internet—for free—to other programmers, to use, test and modify it as they saw fit, more and more programmers contributed their ideas for improvement. Within three years, this informal group, working without managers and connected mainly through the Internet, has turned Linux into one of the best versions of Unix ever created. Imagine now how such a software development project would have been organized at a company such as IBM or Microsoft. Decisions and funds would have been filtered through layers of managers. Formal teams would have been established and assigned task. There would have budgets, milestones, deadlines and status meetings—along with the accompanying turf wars, overruns and delays. The project would have cost an enormous amount of money, taken years to complete and quite possibly produced a system less valuable to users than Linux. What the Linux story really shows is the power of a new technology—in this case electronic networks—to change fundamentally the way work is done. The Linux community, a temporary, self-managed gathering of individuals engaged in a common task, is a model for a new kind of business organisation that could form the basis of a virtual company.

A temporary, self-managed gathering of individuals engaged in a common task, could form the basis of a virtual company.

The fundamental unit of this economy is not the corporation but the individual. Tasks are not assigned and controlled through a stable chain of management but rather are carried out autonomously by independent contractors. These electronically connected freelancers—"e-lancers" (Malone & Laubacker, 1998)—join together as fluid, temporary networks to produce and sell goods and services. When the job is done—after a day, a month, a year—the network dissolves and its members become free agents again, circulating through the economy, seeking the next assignment.

Electronically connected freelancers—"e-lancers"—join together as fluid, temporary networks to produce and sell goods and services.

Temporary Networking—'Small' is becoming good

Far from being a wild hypothesis, the e-lance economy is, in many ways, already upon us. We see it not only in the development of Linux but in the evolution of the Internet itself. We see it in the emergence of virtual companies, in the rise of outsourcing and telecommuting, and in the proliferation of freelance and temporary workers. Even within large organisations, we see it in the increasing importance of ad hoc project teams, in the rise of "entrepreneurs" and in the formation of independent business units. All these trends point to the development of large, permanent corporations into flexible, temporary networks of individuals (Mowshowitz, 1997). No one can yet say exactly how important or widespread this new form of business organisation will become, but judging from current signs, it could conceivably define work in the 21st century, just as the industrial organisation defined it in the 20th. If it does, business and society will be changed forever. A future of temporary networks would seem to run counter to the wave of mergers sweeping the global economy. Yet when we look beneath the surface of all merger and acquisition activity, we see signs of a counter- phenomenon: the disintegration of the large corporation. Even within large corporations, decisions are increasingly being pushed to lower levels. Workers are rewarded not for efficiently carrying out orders but

for figuring out what needs to be done and doing it. Many large industries – ABB and BP Amoco are among the most prominent – have broken themselves up into numerous independent units that transact business with one another almost as if they were separate companies.

What underlines this trend? The answers lie in the basic economics of organisations. Business organisations are, in essence, mechanisms for co-ordination. They exist to guide the flow of work, materials, ideas and money, and the form they take is strongly affected by the co-ordination technologies available. When it is cheaper to conduct transaction internally, within the bounds of a corporation, organisations grow larger, but when it is cheaper to conduct them externally, with independent entities in the open market, organisations stay small or shrink. The co-ordination technologies of the industrial era – the train and the telegraph, the car and the telephone, the mainframe computer and the fax machine – made internal transactions not only possible but also advantageous. Companies were able to manage large organisations centrally, which provide them with economies of scale in manufacturing, marketing, distribution and other activities. It made economic sense to control many different functions and businesses directly and to hire the legions of administration and supervisors needed to manage them. Big was good. But with the introduction of powerful personal computers and broad electronic networks – the co-ordination technologies of the 21st century – the economic equation changes. Because information can be shared instantly and inexpensively among many people in many locations, the value of centralized decision-making and bureaucracy decreases. Individuals can manage themselves, co-ordinating their efforts through electronic links with other independent parties. Small becomes good.

The value of centralized decision-making decreases because information can be shared instantly and inexpensively among many people in many locations.

In one sense, the new co-ordination technologies enable us to return to the preindustrial organisational model of small, autonomous business-businesses with a workforce of just one or a few – conducting transactions with one another in a market. But there is one crucial difference: electronic networks enable these microbusinesses to tap into the global reservoirs of information, expertise and financing that used to be available only to large companies. The small companies enjoy many of the benefits of the big without sacrificing the leanness, flexibility and creativity of the small.

In the future, as communications technologies advance and networks become more efficient, the shift to e-lancing promises to accelerate. Should this happen, the dominant business organisation of the future may not be a stable, permanent corporation but rather an elastic network that might sometimes exist for no more than a day or two. We will enter the age of the temporary company.

The dominant business organisation of the future may not be a stable, permanent corporation but an elastic network.

From the 1920's to the 1940's the movie business was controlled by big studios such as MGM and Columbia. They employed actors, directors, writers, photographers, publicist, even projectionists – all the people needed to produce a movie, get it into cinemas and fill the seats. The film industry was a model of big-company, industrial organisation. By the 1950's, however, the studio system had begun to disintegrate and power gradually shifted from the studio to the individual. Actors, directors and screenwriters became freelancers and made their own choices about which projects to work on. Today, independent producers initiate projects, assemble financing and bring together teams of freelancers to join temporary companies. Once a film is finished, the company that made it goes out of existence, but its members, in time, join together in new combinations to work on new projects. The shift in the film business from permanent companies to temporary companies shows how entire industries can evolve rapidly from centralized to network structures. Such transformations are by no means limited to the idiosyncratic world of Hollywood; consider how manufacturers today are pursuing radical outsourcing strategies and letting external agents perform more of their traditional activities.

An extreme example is the fashion accessories company Topsy Tail, which has revenues of $80 million but only three employees and never even touches its products through the entire supply chain. It contracts with injection-moulding companies to manufacture its goods; it uses design agencies to create its packaging; and it distributes and sells its products through a network of independent fulfillment houses, distributors and sales representatives. Another, broader, example is the textile industry in the

Prato region of Italy[1]. More than 15,000 small textile firms, averaging fewer than five employees, are active there. These tiny firms operate state-of-the art factories and warehouses and have developed co-operative ventures in such areas as purchasing, logistics, and research and development, where scale economies can be exploited. Brokers, known as impannatori act as conduits between the firms and textile buyers. The, impannatori help co-ordinate design and manufacturing by bringing together appropriate groups of business to meet the particular needs of a customer. They have even created an electronic market, which allows textile production capacity to be traded like a commodity. Prato, however, is a relatively small and homogeneous region. How would a complex, diverse industry operate under the network model? The answer is: far more easily than one might expect. As a thought experiment let us take a brief journey forward in time, into the middle of the 21st century, and see how cars the archetypal industrial product, are being designed.

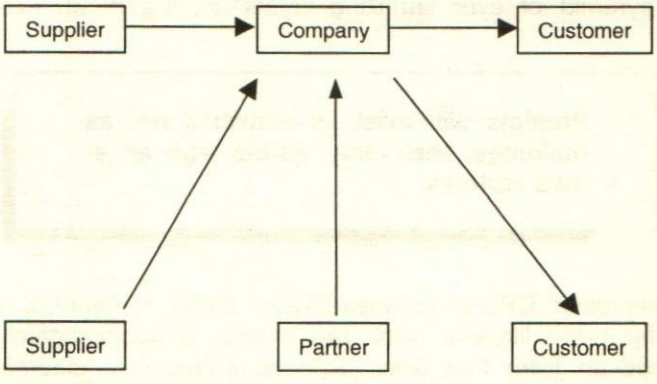
General Motors, we find, has split into several dozen separate divisions, and these divisions have outsourced most of their traditional activities. They are now small companies concerned mainly with managing brands and funding the development of new perform fabrication and assembly on a contract basis. Freelance engineers and coalitions plan vehicles, who join together in small, ever shifting engineering and electrical system, while another may concentrate on managing the integration of subsystems into complete cars. These design coalitions are autonomous and self-organising, and all depend on a universal, high-speed computer network for communication and transfer of money. A highly developed venture capital infrastructure monitors and assesses the various teams and finances the most promising.

A shift towards a virtual organisation would bring about fundamental changes in virtually every business function, not just product design. Supply chains would become ad hoc structures, assembled to fit the needs of a particular project and disassembled when the project ended. Manufacturing capacity would be bought and sold in open markets. And independent, specialized manufacturing companies would undertake small batch orders for a variety of brokers, design shops and even consumers. Marketing would be performed in some cases by brokers, in other cases by small companies that would own brands and certify the quality of the merchandise sold under them. In still other cases, the ability of consumers to share information on the Internet would render marketing obsolete; consumers would simply "swarm" around the best offerings. Financing would come less from retained earnings and big equity markets and more from venture capitalists and interested individuals. Small investors might trade shares in ad hoc, project-based enterprise via the Internet. Business would be transformed. But the greatest changes would be in the function of management itself.

A shift towards a virtual organisation would bring about fundamental changes in every business function.

The Virtual Organisation

Organisations had a physical representation like factories or trading estates or offices in city centers. They could be identified by nameplates on buildings that were owned, rented or leased. Work was performed by people who were employed, on a full time basis and on standard terms and conditions. Particular employers had a significant impact upon local communities through the physical impact of a mill, plant or works, and as a consequence of the number of people they employed. Today, many organisations, for example dot.com companies like amazon.com and yahoo.com, can no longer be so easily identified. Their footprint is light. There is greater diversity and the boundaries, reach and impact of companies is more difficult to determine. There are electronic links forward to customers, backward to suppliers and sideways to business partners (Dell Michael, 1998) (Fig. 1).



Source: Coulson, 1992.

Fig. 1. Supply Chain Relationships

Ignoring technology, conceptually the idea of an activity without a building as its home is not new. When an organisation's functioning is dependent on information

1. Much of the history is documented in "The Virtual Corporation" by Richard S. Malone and William H. Davidow (Harper Collins, 1992),

flow, all the people are not needed at the same place and at the same time, like, a network of sales people, which is so common that we might not give it such a grandiose title such as a virtual organisation (Handy, 1995). Yet salespeople operate on their own, out of no common place – out of sight but not out of touch or, for that matter, out of line.

Journalism provides another example. The Open University is perhaps the most ambitious example of a concept without a place. The Open University has a home base but none of the students and few of the faculty are to be found there. The home base serves as the administrative hub. For example, The central library in Norwich, Great Britain, serving the eastern region of the country was burned to the ground in 1994. The librarian considered replacing the grand building with a network of tiny libraries in every hamlet and town throughout the region, each linked to a central facility and, to every library in the world, if need be. What will hold the librarian back, however, is not the technology or the money – both are potentially available but the heart and minds of his staff and his political masters.

Larger parts of organisations will now be made up of ad hoc mini organisations, projects collated for a particular time and purpose, drawing their participants from both inside and outside the parent Organisation (Dell, 1998). The projects often will have no one place to call their own (Fig. 2). They will exist as activities not as buildings; their only visible sign is an e-mail address. In international Business, Video conferencing is fast becoming the norm. If there is an office in the future, it will be more like a clubhouse; a place for meeting, eating and greeting, with rooms reserved for activities, not for particular people. The organisational chart of large-scale enterprise had long been defined as a pyramid of ever shrinking layers leading to an omnipresent CEO at its apex (Byrne, 2000). In future, it is far more likely to look like a web; a flat, intricately woven form that links partners, employees, external contractors, suppliers, and customers in various collaborations. The players will grow more and more interdependent. Fewer companies will try to master all the disciplines necessary to produce and market their goods but will instead outsource skills – from research and development to manufacturing – to outsiders who can perform those functions with greater efficiency. Managing this intricate network of partners, spin-off enterprises, contractors and freelancers will be as important as managing internal operations. Indeed, it will be hard to tell the difference. All of these constituents will be directly linked in ways that will make it nearly impossible for outsiders to know where the individual firm begins and where it ends. It must be predicated on constant change, not stability; organized around networks, not rigid hierarchies; built on shifting partnerships and alliances, not self sufficiency; and constructed on technological advantages, not bricks and mortar. Already, old business models that emphasized fixed assets, working capital, and economies of scale have become increasingly vulnerable to nimbler organisations that employ new technologies to reduce costs.

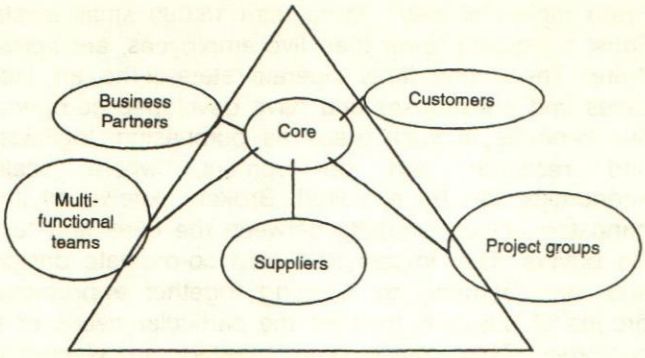


Fig. 2. The International Network Organisation

Projects will exist as activities not as buildings; their only visible sign an e-mail address.

Companies will be predicated on constant change, not stability; organized around networks, not rigid hierarchies; and constructed on technological advantages, not bricks and mortar.

As corporations refocus on their core competencies and move away from vertical integration, they will obtain complementary assets through interfirm relationships (Hedberg et al, 1997).

How Virtual is being used Virtuously

The Future is coming at Internet speed, and with it the very nature of business is changing (Malone & Thomas W., 1998). Today's trailblazing corporations are moving more of their business online in ways that were unimaginable even a year ago. Whether it's Charles Schwab & Co., America's biggest discount brokerage, moving more than 40 per cent of its trade online, Or

Cisco, routing and other network products manufacturer, saving a quarter billion dollars in costs via Web sales. Or National Semiconductor, the maker of analog computer chips for appliances like TV-set top boxes and wireless phones, booking a billion dollars in new business on its extranet, these users are setting a new platform for business. Trimming costs and creating partners and customers, emerges the Virtual Organisation.

Consider the following examples of how going virtual benefits some of the leading companies. Confectionery companies like Nestle, Mars, and others get their packaging from leading packaging and printing companies. Nike and Reebok get their shoes, based on their proprietary designs, from leading Asian contractors. Chrysler's turnaround credited to its outsourcing capabilities, reflected in relatively higher percentage of contracted parts. Dell's success is attributed to its superior sourcing strategy. Boeing developed its latest plane, Boeing 777, with a portfolio of relationships among subcontractors and lead customers. Cisco Systems has taken the concept to an extreme. It owns only two of the 34 plants that produce its products. It concentrates on two essential processes—developing new products and selling products to customers—and leaves the rest to other companies. A contract manufacturer assembles the products from parts made by suppliers, and a materials Management Company ensures the right amount of inventory is on hand, then delivers assembled product to customers. Roughly 90 per cent of orders come into the company without ever being touched by human hands, and 52 per cent of them are fulfilled without a Cisco employee being involved.

Puma, following in another sporting goods manufacturer Nike's footprint, acts as a virtual company. Strategy, marketing and network coordination—the core functions of the company—reside in Germany. A central purchasing organisation and a distributed purchasing network are in Asia; manufacturing is in China, Taiwan, Indonesia and Korea; logistics is in Hong Kong; sales and distribution networks are in Europe, Africa, North America, Asia and Australia. 80 globally dispersed partner companies do everything except those core functions. By end of 1996, the original 1,200 employees were trimmed down to 500. And the company was able to pay dividend to its shareholders. Nike assembles the required capabilities through a coalition, including production subcontracting in Asia, ad agencies (Weiden- Kennedy), web support (Vivid Publishing), retail outlets (Footlocker), exclusive contracts with athletes (Michael Jordan, Tiger Woods, Andre Agassi), preferred contracts with professional teams (Dallas cowboys), and universities (Ohio State football, University of North Carolina basketball) (Venkatraman N. & Henderson, 1998). Nike's advantage is based on the superior orchestration of its position and its success will depend on proactively adapting its network to respond to new market requirements.

In an even more radical move, Mhyar Motragjhi built the PC-display business of the Finnish Company Nokia against fierce competition in the U.S. Beginning in 1992 with starting capital of $100,000, Motraghi invested in marketing and information brochures. With a turnover of $160 million, he now owns about six per cent of the 17-inch display market in the U.S., where his company has already "ballooned" to five people—including himself. He and an assistant control the brand name and marketing activities, and with two other finance specialists, Motraghi manages the finance issue. Local sales partners with the best knowledge of the actual markets are spread all over the U.S; customer service is handled by technical experts from Raleigh, North Carolina; logistics is centered in Charleston, South Carolina, and Oakland, California. Communication is handled in Sausalito, California; advertising and promotion are located in Mountainview, California. Manufacturing remains at the Mother Company's site in Salo, Finland. The network controls itself by extensive use of Video conferencing and the Internet. Motraghi's major competitive advantage is speed, flexibility, and a very lean structure. Without any concern for hierarchical touchiness, Nokia can address a new customer need or solve a major problem within weeks instead of years.

In all of these situations, it is difficult to determine where one company begins and other ends; the members of the virtual organisation are tightly woven together. In virtual organisation, no single company can point to a final product and say, "we did that." Companies perform processes rather than produce complete products. When these processes work together, the final product results.

Companies perform processes rather than produce complete products. When these processes work together, the final product results.

The mixture of economics and technology will make us spend more time in virtual space. Our colleagues will not be down the corridor, available for an unscheduled meeting. Most meetings will be scheduled, even those on video, and will therefore become more infrequent. We will have to manage organisations without meetings. We will have to work with and manage those, whom we do not see, except in rare and prearranged occasions (Davenport & Pearlson, 1998).

Network will make this possible. It could strengthen bonds within the group, promote exchange of experience and cooperation. Thus, an organisation such as British Petroleum encourages networking across departmental and national borders, while business units of Hoechst exist as groupwide networks. In the case of Reuters or Thomas Cook, network is the business. Large companies like Texas Instruments, Jaguar and Motorola have used emerging technologies of electronic commerce to build learning with networks their supply chain partners. With the increasing trend toward outsourcing, teleworking and electronic commerce, virtual organisations can and do embrace people who work in a diversity of ways in widely scattered locations, and collaborate through a variety of contractual arrangements. Virtual models (Speier, Harveu & Palmer, 1998) of operations are being increasingly adopted by business for securing flexible access to skills and capabilities. People have a variety of choices in terms of where, when, how and with whom to work and learn. Emerging technologies can work in a diversity of ways in widely scattered locations, and collaborate through a variety of contractual arrangements. The resulting virtual teams will be held together by shared visions and values, common opportunities and compatible goals and belief.

Organisations no longer need to pursue impossible objectives, such as being world class at everything. In more interdependent and collaborative world, competition is increasingly between consortia or networks of cooperating organisations, rather than individual enterprises. Communications technologies and webs of contractual commitments link the members of these networks.

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Virtual Integration

As the competition grows, companies are turning to Virtual Integration, which lets them concentrate on processes in which they can be world class, and rely on someone else to perform the rest. The Virtual Organisation (also known as Virtual Integration) (Hammer, 2000) is changing the entire concept of what it means to be a company.

In the early 20th century, Henry Ford's River Rouge plant achieved the height of vertical integration: in came iron ore and rubber, out came automobiles. Ford made his own steel, tires, and parts, then assembled them into cars. Although few other companies ever achieved this degree of self-sufficiency, the idea of vertical integration underlay business strategy throughout the century. Companies wanted to control their own destiny and do everything for themselves; they only reluctantly used others as a source of parts or as a means of reaching their customers. In today's hyper competitive environment, however companies can't afford to be second rate at anything. Yet in an ever more complex world, it's impossible for any one company to be tops at everything. The solution in many cases is Virtual Integration – concentrate on processes on which you can be world class, and rely on someone else to perform the rest.

Virtual Integration goes far beyond outsourcing, in which a company lets others take care of non-essential functions. In a virtual organisation, specialist firms perform critical processes – not because they are unimportant, but rather they are so important that the original company can not afford to have them handled in a mediocre way.

Virtual Integration goes far beyond outsourcing, in which a company lets others take care of non-essential functions.

The key to successful virtual integration is to enable all companies involved, each of which is performing only certain processes, to work together as smoothly as they would if they were all one organisation. Enter the Internet. As a transport mechanism, the Net allows rapid, low-cost communication between businesses. Just as important, technologies that build on the Internet (such as Extensible Markup Language) let the systems of all participants in a virtual organisation mesh smoothly.

The implications of Virtual integration dwarf those of e-commerce. As virtual integration spreads, companies will increasingly define themselves in terms of the processes they perform, rather than the products or services they produce. The ability to integrate with others

The ability to integrate with others will become core competence.

will become a virtual core competence. New corporate culture that value cooperation and sharing will emerge.

As information and communication technologies overcome the constraints of time and distance, it becomes possible to create virtual organisations. Virtual is usually taken to be something that does not exist in reality. So a typical definition of a Virtual organisation (taking the dimension of time) can be: "a temporary network of independent organisations linked by IT to share skills, costs, and access to one another's markets". However, another definition relates to an organisation not having a clear physical locus. Here a typical definition is: "an organisation distributed geographically and whose work is coordinated through electronic communication". Both definitions show how information and communication technologies can be used to exploit the dimensions of time and space. A virtual organisation is a specific example of Networked Organisation. Many smaller companies are now realizing the benefits of the resources of a large organisation while retaining the agility and independence of a small one.

Characteristics of Virtual Organisations

The characteristics of the emerging virtual organisations described above are significantly different from those we find in old fashioned, hierarchical companies. A virtual organisation seems to have five characteristics in common.

- They have a shared vision and goal and/or common protocol of cooperation.
- They cluster activities around their core competencies.
- They work jointly in teams of core competence groups, like those created by 'impannatores' in the Prato network, to implement their activities in one holistic approach throughout the value chain.
- They process and distribute information in real time throughout the entire network, which allows them to make decisions and coordinate actions quickly.
- They tend to delegate from the bottom up whenever economies of scale can be achieved, new conditions arise, or a specific competence is required for serving the needs of the whole group.

Benefits of Virtual Organisation

These trends present 'good news' for those individuals and small and specialist suppliers that focus on and aim to be outstanding at what they do best. However, they are often 'bad news' for those who are jacks of all trades but masters of none; those who are not distinctive and whose only drive appears to be survival. Customers need no longer accept second best, or just put up with what is available, when a supplier that can offer more may be only seconds away by telephone, fax or a e-mail. Multiple alternatives can be sought through the use of search engines and menus. Those who absolutely excel are courted, while the merely very good are ignored. While large physical establishments may still be needed to manufacture products such as aircraft, in many sectors, virtual organisations composed of 'members' or 'business partners' specializing according to capability and interest compete successfully with larger corporations. With many of their previous areas of advantage being eroded by developments in new technologies, an increasing number of larger companies have to rely upon brand image and loyalty as their last line of defense.

The process of becoming a multinational used to consist of setting up or acquiring premises and staff in overseas locations. This could involve the formation of a local company and often lead to a host of legal, financial, taxation, regulatory and expatriate management issues. In order to address such complex questions and control, coordinate and consolidate, corporations were required to employ teams of 'high level' professional staff at corporate head offices, whose cost represented a barrier to potential new entrants. For many businesses today it need no longer take generations to build an operating international distribution network. The Internet allows international communication for the price of a local call. Within days of registration with search engines, a web site may receive 'hits' from visitors all over the world, and take orders direct from customers. Relevant contacts can be quickly followed up and global coverage secured in a matter of weeks. The emerging technologies of electronic commerce are democratizing business opportunities. Individual self-employed professional and knowledge workers can afford the technology to operate internationally via a personal computer (PC) in a home office. Simple peasants producing craft goods can cooperate to provide store

It need no longer take generations to build an operating international distribution network. The Internet allows international communication for the price of a local call.

buyers with electronic ordering systems that are superior to those offered by major manufactures. Virtual operation offers small enterprises levels of flexibility and responsiveness that many large corporations struggle to achieve.

Every corporate giant is not doomed to be defeated by Internet operating small and medium enterprises (SMEs). The experience of corporations such as 3M suggests that flexibility is not necessarily incompatible with scale. However, not all major companies will survive. Virtual organisations made up of network partners, each of whom specializes according to capability, interest and comparative advantage, can compete successfully with larger organisations. Thus companies such as Kingston Technology Corporation, with last year sales of $1.4 billions is the world's largest maker of after market modules, which are used to expand memory in computers, have grown rapidly from start up to international operations on the basis of a network of relationships based upon trust and shared vision. As technology becomes more pervasive and less visible, greater emphasis is placed upon learning, thinking and sharing, rather than just communicating. The learning and earning network will embrace shifting communities of micro units, autonomous and self-managing teams and individual gurus who could be located almost anywhere.

Making Virtual Organisation Tick

A shared vision, a common protocol of cooperation, and a holistic approach throughout the value chain require that the members of virtual organisations share certain attitudes and behavioral patterns. As demonstrated in the real-world examples, four key attitudes and behaviors seem to emerge:

Open and spontaneous communication is the basis for building trust and establishing relationships. Trust and relationships cannot be developed through electronic communication alone. People need to come together so they can know and value each other.

Trust and being trustworthy is an essential for all collaborative and cooperative work.

Entrepreneurism and risk taking as personal values encourage individuals to take initiative that focus on results achieved rather than simply being paid for the time spent on the job.

Functional excellence is a pervasive attitude that helps to dedicate everyone to achieving the highest quality results for customers.

Social & Legal Implications

Over time, the virtual form of organisations will have a significant impact on social programs such as Social Security and on legal and tax matters as well. As more people become self employed "experts" in a virtual company environment, social programs cannot give back more than has been paid in. This new understanding could lead to greater self-responsibility and special programs with adjusted premiums to benefit groups with specific risks. But this development is still in its very early states. Corporate law, on the other hand, is already being challenged in connection with taxes. For example, if services are generated in cyberspace (e.g., software production, in which people from around the globe are inter linked by GroupWare to work on the same development project), a participant-owned "inverted holding" can reside anywhere in the world and aggregate most of the profit. As long as there are different tax systems in different countries, these holdings may grow in the more tax-friendly places.

Hardware manufactures can also benefit. Practical examples show that the so-called "commissionaire structure" is one of the potential opportunities. Commissioners are legal entities in countries where products are sold; they focus on the service that has to be delivered in that country, e.g., sales. The sales function is paid for as a percentage commission of sales volume. Services such as invoicing, posting, shipping of goods, physical distributing, warehousing, and the remaining activities of the supply chain can be located where the optimal, overall cost structure (including taxes) occurs. Countries in Europe are now competing with tax schemes to get or keep labor and production locations.

The tempo of the market may also make it difficult for lawyers to draw up and get approval of written contracts for products and services. The chip manufacturer LSI Logic (Malone & Davidow, 1992) secured its customer relations with strict contracts until managers discovered that they were able to produce and deliver products faster than customers could check the contracts. Wilf Corrigan, chief executive of LSI said, "Some of our especially dynamic customers told us, 'Listen—you can rely on our verbal agreement, so start your production. Our schedules are so tight, we cannot wait until the contracts have been approved by all of our and your departments." So LCI, the biggest manufacturer of gate arrays in the United States, began production and now builds its customer relations on trust.

Vision & Reality

There is much evidence that most companies un-

derstand that being successful in the marketplace means addressing individual and personal customer needs above everything. The virtual organisation facilitates this goal, and the unprecedented possibilities of the emerging information/communication industry offer many opportunities for implementing such a strategy. But technological solutions cannot replace the basic need for purposeful leadership. Technology is an enabler for doing things differently and faster than before, but the content and direction of the message still make the difference between ultimate success or failure.

Beyond the importance of a sound vision and valid strategy, four things have proven to be helpful for organisations to become virtual:

- Identifying and forming a shared understanding of the actual and target core competencies to trigger learning and people development.
- Providing an infrastructure that supports knowledge sharing, communicating, and work on joint projects by locally dispersed teams.
- Monitoring and measuring not only the "hard" facts of business performance but also the "soft" facts that indicate qualitative improvements of services and people.
- Shifting from a time-based pay system to rewarding and compensating individual and team improvement and performance by a variety of means, including financial ownership of the entity.

These factors drive people, organisations, and companies to focus on their core competencies and trigger networking with people to whom non-core activities have been outsourced.

New paradigms do not emerge abruptly—they grow out of behavioral responses to the realities of the environment. The rapidly growing information/communication industry will shape the new framework conditions, and many versions of the virtual organisation will evolve. As they form and re-form, these organisations will require leaders who have a totally new mental map—leaders who can shift from the time-honored paradigm of the industrial age to a performance-honored paradigm of the information age.

Most of what is described here may be speculative. The future of business may turn out to be far less—or far more—revolutionary. Virtual organisation may be a radical concept, it is by no means an impossible or even an implausible one. Most of the necessary building blocks—high bandwidth networks, data interchange standards, groupware, electronic currency, venture capital micro-markets—are developed or under development.

What is lagging behind technology is our imagination. Few people are able to conceive for a complete virtual organisation, where much of what they know about organisations no longer applies. When we look at a flock of birds flying in formation, we tend to assume that the bird in front is the leader and is determining the organisation of other birds. In fact, biologically, each bird is following a simple set of rules—behaviorial standards—from which the organisation emerges. The bird in front is no more important than the bird at the back or a bird in the middle. They are all equally essential to the pattern.

The virtual organisation might well lead to a flowering of wealth, freedom, and creativity but it might also lead to disruption and dislocation. Free-agent workers, separated from safety nets of today may find themselves lonely, alienated and separated. To seize the opportunities of this possible golden age of business and to avoid potential problems, we need to think as creatively, and as wisely, as we possibly can.

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News & Notes

Cooperation with local suppliers: LG Electronics

Foreign affiliates use advanced and systematic techniques for transferring technology and information to linked enterprises, based on their experience elsewhere. For instance, the Indian affiliate of the Korean TNC, LG Electronics, uses techniques for supplier development such as "early supplier involvement" to implement the Six Sigma system of statistical analysis for quality and productivity improvement. It helps them with process redesign and re-engineering and direct on-line supply. It provides them with global cost benchmarks, data not easily available to local counterparts. Suppliers are provided with assistance is "factory innovation" to improve quality and profits. Some are helped to set up facilities close to the buyer to improve logistics. Selected vendor employees are sent to overseas plants invited to regular meetings and presented with awards. They can participate in LG's training programmes and are instructed in e-commerce techniques. By being exposed to global quality and cost standards, they can meet export market demands directly; LG helps them to enter export markets.

Fostering linkages with local suppliers: Toyota Motor

Toyota Motor Thailand (TMT) has established an extensive network of linkages with supplier firms within the country. TMT's first-tier suppliers in January 2001 comprised 575 firms, of which 134 supplied core autoparts and 441 supplied other materials and facilities (table 1). Of the former, Japanese joint ventures and Toyota-related companies accounted for 55 per cent of firms and 79 per cent of the value of supplies. Thai firms with Japanese technical assistance and other Thai firms accounted for 27 per cent of the number of suppliers but only 8 per cent of the value of supplies. In the case of materials and facilities, wholly owned Thai firms accounted for 60 per cent of the number of suppliers, but only 14 per cent of the supplied value. It is estimated that the second–through fourth-tier suppliers of TMT's supply chain comprise around 1,500 largely Thai-owned firms, but the actual number may be lower since the economic crisis of 1997-1998 caused serious financial problems for many smaller suppliers.

During the economic downturn following the East Asian financial crisis, TMT gave significant financial support to its first-tier suppliers. In order to prevent bankruptcies among its suppliers, TMT provided 1.6 billion baht from Toyota Motor (Japan) through a number of programmes: an advance payment revolving fund; dead stock purchase schemes at cost; and advance payments for tooling expenses.

Toyota has declared its intention to procure all, parts and components locally (100 per cent local procurement–as distinguished from 100 per cent local content) at TMT by 2003, rising from its present level of around 70 per cent. In order to achieve this, TMT announced a special project in 2000 ("Thai for Excellent Project") and explained the plan to its suppliers. Toyota decided to aim for 100 per cent local procurement in the anticipation of the automotive liberalization foreseen by the ASEAN Free Trade Area in 2003, and in response to high competition with other automobile companies.

This is the first time that Toyota seeks full local procurement. Eventually this approach could also be extended to other ASEAN countries. The reason why this approach was pioneered in Thailand is that Toyota had already established a wide range of supporting industries there, including for key components, such as engines and major body parts. These key components are generally produced by Toyota's affiliates (not by domestic firms). The major remaining parts to be procured locally include certain precision transmission parts and electronic controls.

Table 1: Local procurement by Toyota Motor Thailand, 2001, by type of supplier and type of input

Type of supplier	Purchasing of key parts and components		Purchasing of other materials and facilities	
	Number of suppliers	Distribution of purchases (Per cent)	Number of suppliers	Distribution of purchases (Per cent)
Toyota-owned firms in Thailand	4	37	–	–
Japanese joint ventures	69	42	103	78
Thai firms with Japanese technical assistance	17	7	3	2
Non-Japanese joint ventures	6	2	71	6
Pure Thai firms	19	1	264	14
Firms in ASEAN under the ASEAN BBC programme[a]	19	11	–	–
Total	134	100	441	100

[a]Brand-to-brand complementation scheme.

Toyota Cooperation Club

The Toyota Cooperation Club (TCC) plays an important role in TMT's efforts to strengthen its local suppliers' capabilities. TCC is an association of suppliers to TMT, with a current membership of 92 first-tier suppliers. Suppliers eligible to apply for membership must have annual sales of five million baht to TMT and at least a three-year relationship. There are currently six major types of activities at the TCC: (1) annual conferences; (2) TCC Executive Committee meetings; (3) Quality Assurance Kaizen (steady improvements) activities; (4) Cost Kaizen activities; (5) quality control circle activities; and (6) TCC lectures.

These activities are open to all members of the TCC. Activities (3) through (5) are limited to first-tier suppliers, while activity (6) is open to all suppliers. Although TMT was involved in the establishment of the suppliers' association, the major players in the activities of the Association are its key suppliers. The Executive Committee of TCC consists of representatives from its 12 key suppliers, which include not only some Japanese subcontractors in Thailand (e.g. Denso (Thailand), but also domestic suppliers (e.g. CH. Auto Parts Co.).

The members of the Executive Committee host various activities at their companies to diffuse the Toyota Production System and quality control mechanisms to other local suppliers. For example, some members organize a series of seminars/training courses on issues related to cost-efficiency, quality assurance and delivery. There are also study groups on, e.g. plant operation with a view to proposing ways and means to utilize Kaizen. In these activities, TMT and Toyota's Operation Management Division in Japan provide technical advice and guidance. Toyota's approach is to encourage suppliers to make their own efforts to improve their competitiveness, in a voluntary learning process ("jishiuken").

The TCC has not only provided opportunities for suppliers to learn best practices from each other in management and quality control, but also fostered cooperation among suppliers. In addition, a "Supplier Centre" has been set up at TMT headquarters to provide the necessary information for its suppliers. This includes prototypes of all major parts, lists of suppliers and their performance for each month, and information on specifications of major parts and components.

Although TMT appears to be interested in extending the activities of the TCC to tier-two to tier-four suppliers, the programmes to support these suppliers are relatively weak. This is due in part to the desire of the first tier suppliers to deal with their own suppliers by themselves and to be responsible for them, and in part due to a lack of resources (both financial and personnel) on the part of TMT. With some exceptions, TMT efforts are limited to encouraging first-tier suppliers to work with their own suppliers in a similar manner to that adopted by TMT with its first suppliers. Innovative ways of involving lower-tier suppliers in some of the higher-level activities of the TCC are needed to upgrade capabilities and understanding. Government support to such activities could help to reach local suppliers.

The SMART model of Intel Malaysia

Intel Malaysia has developed one of the most comprehensive programmes for supporting supplier development and upgrading. Local suppliers are used by Intel in the areas of subcontracting, tooling and fabrication, equipment service support, transportation and packaging, operating supplies, construction and infrastructure support as well as information technology supplies.

Intel's so-called "SMART" approach consists of five steps. The first is to select suppliers that are willing and capable of participating in the programme. Potential candidates are sought via open houses and links with business organisations like the Small and Medium In-

dustries Development Corporation and various Chambers of Commerce. Intel analyses a candidate from four perspectives: its management (including the vision of the CEO and the companies' financial stability); its human resources; its technical, materials and process capabilities; and its cost competitiveness.

In the second stage, Intel assists selected suppliers by initial training. The next step is to allocate business to suppliers at the level of complexity appropriate to their capabilities and the needs of Intel. Intel then helps raise supplier capabilities by continuous training and coaching. The ultimate and fifth step is to develop firms into global suppliers, with the ability to meet international standards and export directly. The goal is that Intel should not account for more than 20 per cent of any supplier's sales.

Continuous training of suppliers is provided partly by inviting them to send their staff to Intel's internal training courses and partly through courses in the Penang Skills Development Centre (PSDC). PSDC analyses gaps in the capability of the suppliers' workforce and provides courses to plug these gaps. While the PSDC assumes responsibility to package and deliver the courses, most courses are contributed by Intel and other foreign affiliates in Penang.

Coaching involves regular supplier reviews and continuous dialogue. Through the supplier reviews, Intel shares new information on technical roadmaps and expected future technical and business requirements early in the process. When appropriate, teams of engineers or relevant experts from Intel are sent to suppliers to assist.

A number of suppliers have participated in Intel's programme. According to the company's estimates, about four out of five selected companies eventually become suppliers. For "direct" suppliers, which supply large volumes of components, the success rate is almost 100 per cent. Intel Malaysia spends extra resources on coaching these suppliers. In the case of "indirect" suppliers, the success rate is about 70 per cent. Several SMEs have eventually become TNCs in their own right. In 2000, six were listed on the main board of Kuala Lumpur Stock Exchange, while another seven were listed on the second board.

According to Intel, tax incentives provided by the Government have been important in motivating it to invest in developing local SMEs as suppliers. Under the "Pioneer" scheme, Intel has negotiated with the Government and agreed on a financial support package, from which it benefits if it meets certain agreed criteria, including one relating to supplier development. Currently, according to Intel, the tax incentives are about $50 million per year. There are also specific government funds available, which suppliers can use to finance upgrading efforts. TNCs in Penang work closely with government institutions and PSDC.

Motorola's backward linkage programme

Since its establishment in China in 1987, Motorola has become one of the country's largest inward investors, with a direct investment stake of more than $3.4 billion, two wholly owned affiliates, 8 joint ventures, and 18 R&D centres.

Working in full partnership with China's State Development and Planning Commission (SDPC), Motorola has established the Centre for Enterprise Excellence, a programme to provide high-level training to selected state-owned enterprises. The main objective of the programme is to develop Motorola's supplier based by strengthening especially quality, production and productivity through classroom and on-site instruction as well as outreach activities. Motorola and the SDPC have developed a three-step model for that purpose: training of participants for two weeks; selection of high-potential state-owned enterprises for further development (after a 6-12 months joint effort, Motorola qualifies selected enterprises as suppliers); and provision of finance, jointly with the SDPC, to selected firms. This final step has so far not been implemented as the firms selected have had access to alternative sources of funding.

Since 1998, Motorola and SDPC HAVE developed a training curriculum in quality and productivity management for the chief executive officers, managers and technical staff of selected Chinese state-owned enterprises. They recruit and train professors from major universities in Beijing and Tianjin to provide courses in areas such as leadership development, strategic planning, marketing, quality control (Six Sigma), internal controls, finance, and human resource development. By early 2001, 449 enterprises from 23 provinces, covering 1,516 chief executive officers, middle level managers and technicians, have participated in the programme. The trainees come from a wide range of industries, including electronics, telecommunications, computer hardware, software, media, and general trading or commercial enterprises. Motorola and the SDPC plan to expand this programme to reach 1,000 enterprises over the next few years.

Recently the programme was extended beyond Beijing to the interior of Western China. In 2000, Motorola and SDPC held sessions in Xian and Chengdu. By 2001, 400 chief executive officers, middle level managers and technicians from 85

enterprises had participated in the programme there. There are plans to continue this programme in Western China through 2001. By offering to share the company's experience in quality and productivity management with Chinese companies, it contributes to the reform of state-owned enterprises, a priority objective of the Government of China, Taking this programme outside Beijing serves the Government's objective of promoting more balanced growth. the successful reform of the state-owned-enterprise sector contributes, in turn, to a more favourable business environment.

At the same time, the programme supports Motorola's efforts to expand its supplier base and achieve localization goals, which helps Motorola minimize costs, control inventory and reduce new product cycle time, all of which are critical factors for success in an industry characterized by rapid technological change. Moreover, the programme has generated goodwill and enhanced corporate access to central and provincial government leaders.

The programme has been adjusted over time. Initially, the plan was to undertake the training effort together with four or five other TNCs. However, after about a year, these plans were scrapped because each company had its own training priorities and corporate culture and it was difficult to make the programme work for multiple firms. The content of the programme is also continuously updated and new training methods are introduced, such as e-learning as a means to accelerate the dissemination of the training materials.

As of end-2000, 63 of the participating state-owned enterprises had joined the 700-plus Chinese firms currently supplying Motorola. Companies that become certified suppliers to Motorola continue to receive various types of support to ensure they remain qualified. By 2000, the average percentage of locally manufactured parts and components in a cellular phone manufactured in a Motorola plant in China had reached 65 per cent. It is expected that Motorola's local procurement will exceed $1.5 billion, and the number of local suppliers will exceed 1,000 by the end of 2001.

Compiled by:
Arundhati Chattopadhyay
from World Investment Report 2001,
Promoting Linkages
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The man who follows the crowd will never be followed by a crowd.

– Richard S. Donnell

Book Reviews

Stress in Life and at Work *by Dr. Rita Agrawal*, Published by Response books (a Sage Books Division), New Delhi; pages 281, Price Rs. 225 (soft-bound).

The tome is a very objective compilation on the most talked-about topic of the day – Stress and Its Management. Statistics from all leading health institutes have supported its importance in today's life. The problem has been existing and is extensively getting severe in all nooks and corners of human life – at home, society and in professional/career life. Such an important aspect of human life was being ignored in the developing world in the past. Renowned Behavioral Scientists and Therapists are striving hard to find new ways and means to conquer this "cause of disease", equally bugging both the developed and the developing societies thus leading to a large number of 'life-collapse/ breakdowns', deaths, suicides and failed attempts for the same in all segments across the human civilization.

This attempt from the author addresses the concepts and dynamics behind 'Stress in Life and At Work'. It provides philosophical and scientific interpretation of the understanding of the concept in Indian and Western cultures. Indian scholars and researchers tend to ignore the advancements made by the Indus-valley (civilization) i.e. Indian contribution. Author of this tome has acknowledged the Indigenous contribution made in the field by Vedas and other scriptures like Ramayana, Mahabharat etc.

The tome is in three-major sections – Understanding Stress, Stress at the Workplace, and Coping with Stress, First section consists of 8 chapters including subject matter on Models, Sources and Consequences of stress, where the author has also elaborated on stress as life-process. He investigates stress and its roots in Indian traditional as well as western literature. The sources for stress are also compiled extensively as well as prevailing myths and underlying realities. Stress, as viewed in various philosophies namely – Medical, Psychological and Sociological, is described. The models are self-explanatory. The consequential aspect of stress including the concepts of 'Rust Out Stress syndrome (ROSS) and 'Burn Out Stress Syndrome (BOSS)", which have become an important part in human working- life, be it natural, deliberately nurtured by a person for himself, Management-generated or due to 'organisational Systems-error', is also well taken-up.

The second section describes "Stress at the Workplace". It consists of 3 chapters including dynamics at work place and Dual Careers. The section describes the various stages of occupational job-stress and the hypo/hyper-stress (i.e. ROSS/BOSS), elaborately. The cause and effect of occupational stress on/in the individual's life, and the physics and chemistry of the same are explained in detail in this section. The most commendable work done by the author is in highlighting the difference of the conceptual meaning of stress in the life of a man and a woman in occupational and home (social) life. The author has also touched softer but significant issues, widely ranging from 'when to have a child' to 'role-conflicts' over mutual expectations from each other due to individual career priorities, which are one of the major causes of stress in families today, simultaneously affecting the occupational performance. Author has also provided few common tips for the management of stress and adaptation of individuals to cope-up with home & job stress. Sexual harassment in the workplace is also designated as a cause of stress for working-women and its implications on their lives is also included.

The final section relates to 'coping with stress'. This section consists of 4 chapters including a chapter exclusively on the individual and organisational strategies for stress management. The section starts with the definition of Coping and, various underlying concepts and processes pertaining to the same. The author also deals with 'Responding V/s Reacting' aspect of stress-coping strategy through the 'fight or flight' pathway. The individual stress-management described in the tome includes development of various skills and competencies like Relaxation (methods), Time management (including

"The 3D mantra" i.e. Do it, Delegate it and Destroy it), 'Socialisation', 'Yoga', Acupuncture etc. and last, but not the least Medical advice. The organisational strategies discussed in the section describe various HRD interventions related with stress-coping, stressing on the role of managers as mentors or trainers while dealing with the 'BOSS' in organisations and the concept of total "Organisational Development (OD)". The author also deals with 'Change', the development of learning organisation and development of individuals for change aftermaths like Merger & Acquisitions, Restructuring, Job loss etc. 'Positivity' in attitude is recommended as the key to success.

It would have been better if the issue of sexual harassment in workplaces, which is a burning topic in this Women Empowerment Year, had been dealt with in detail. The book has presented various factual data, explanations of related concepts, corresponding research and development & Self-appraisal/Self-analysis for readers (to see whether they are on the verge of threat of stress or how affected they are from it), exhaustively. The user-friendly language and the approach of the tome is appreciable. The book is a worthy addition to individual as well as institutional libraries.

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Training for Organisational Transformation, Part I and II *by Rolf P. Lynton and Udai Pareek,* New Delhi: Sage Publications, 2000. 307+414 pp. Rs. 225 and 275 paper back & hardbound.

Training for Development by Rolf P. Lynton and Udai Pareek, one of the first authentic texts on training in the Indian context, came out in 1967. It was revised in 1986. The book was well received in India where teachers and students of human resource development (HRD) considered it as a training bible. In the last 15 years or so since the second edition of this text came, the organisational world has undergone a sea change including in the postulates and processes of training and development. We can witness the emergence of new concepts and linkages. Among others, these include: popularization of the concept of human resource management (HRM) and human resource development (HRD), shifting of training focus from individuals to teams and its linkage with organisational development (OD) and HRD, shift from programming of training people to developing all into a learning organisation, promoting diversity training as part of diversity management, and meeting the exigencies of network organisation. These developments have shifted the training decisions from line and HR departments to the boardroom, signifying the need for strategic concerns in conceptualization of training and putting it into practice.

Also, the urgency of developing competitive advantage in today's business environment has led to changes in the modern theory of firm, whose focus is moving away from market and on to corporate resources. The resource-based approach for effective management prescribes, among others, that employees' competencies are identified and developed carefully. Thus, we need to translate strategic competencies (which have now come to be labelled as core competencies) of the organisation into personal competencies. The knowledge and developmental potential possessed by the human resource are now believed to be becoming the focal point of the resource-based theory of firm. Developments in HRM literature also suggest that business strategy and HRM strategy have come closer to each other, which signifies increasing importance of HRM; in some cases the latter even influences the former. That is why, both business strategy and human resource management (HRM) strategy view investment in training and development as critical for organisational success. Companies increasingly want to attract and develop intellectually agile, innovative and globally-oriented employees. They also track the careers of talented people and directly communicate with them about their strengths, development needs and personal as well as career aspirations. Training is becoming more holistic now; intensive training programmes are developed for employees so as to instil in them a new management culture where employees are expected to provide quick and effective solution to the problems of customers.

So as to meet the needs of the changed milieu, Lynton and Pareek have revised or re-written their training text in the form of the title under review. Unlike the earlier editions, the authors have divided the new edition into two volumes. Part one focusses on the policy makers and change managers and Part two is addressed to trainers, consultants and principals, The authors claim that each volume is "self contained" and includes enough from the "viewpoint of the other party to make sense of one's own".

Part one discusses issues related to trainers charged with overall development including developers; founders; and managers of training systems, policies, and strategies. The discussion in this part reflects on four key issues that must be addressed by the policy-makers and change managers so that training can add value to the skill and competence levels. These are:

making training fit change strategies; outcome evaluation; organisational readiness and support for training; and ensuring a good fit of training with organisational and wider cultures. The two broad parts in which nine chapters of volume one are divided have been titled: Rethinking Training; and Training Policy and Resources.

Volume two is addressed to the needs of hands-on practitioners of training, and program developers who focus on training process. Its eleven chapters are grouped into three parts. Part one explores the position training has in operating systems and the tasks involved. It leads to identifying the available approaches and strategies and their specifications and likely outcomes. Part two, among others, discusses the range of methods; staff, time, and other specification for each of these; and designing of training programmes. Part three is devoted to managing the training programmes, including: developing a group and climate; trainers and styles; building-in the requisite post-training supports; and evaluation of training or modification of training programmes in the light of the evaluation results. The book ends with a chapter on action research. Trainers, training departments, training strategists have a great deal to learn by studying this wonderfully developed chapter. This will be of considerable help in modeling an appropriate training system. The book gives the clear message that those who don't bother to seek reflection of their training efforts and programmes are bound to lose out. This is especially important in the Indian milieu where a good amount of resources are wasted on badly designed training programmes built on uncritical assessment of training needs and interventions. With the increasing turbulence in the business environment, organisations can ill-afford to be ignorant of the exigencies of the changed times.

There is no doubt that this thoroughly re-written book will deliver considerable value to the reader—be s/he a trainer, training strategist, policy maker, student, teacher or a researcher. The book depicts remarkable lucidity in its contents. It excellently fulfils the changed needs of all those concerned with training as a means for enhancing individual and organisational competencies. The exhibits and boxes add considerable punch to the trainers and HRD managers who usually are not interested in reading about the macro dimensions of training and development. The authors have done a great service to the HRD community by articulating issues in training and putting them in the contemporary competitive context.

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Protection in Indian Manufacturing: An Empirical Study *by Hasheem Nouroz*, Delhi: Macmillan India Limited, 2001, pages 230, price Rs. 395.

Trade reforms in India became more comprehensive in the 1990s. The reforms program essentially included elimination of quantitative restrictions (QR's) on imports and their replacement with tariffs, rationalisation of the tariff structure and simplification of trade procedures. Such trade reforms were initiated in the capital and the intermediate goods sector and the scope was widened over time to include all sectors of the economy. The exchange rate policy also formed a part of the comprehensive trade reforms package. All these policy changes necessarily aim at improving competitiveness by reducing distortions inherent in a protected trade regime.

The book titled Protection in Indian Manufacturing: An Empirical Study by Hasheem Nouroz essentially examines the extent of trade reforms and analyses the impact of a changing trade regime. To map out the extent trade of reforms, Hasheem resorts to an in- depth analysis of tariff changes, provides estimates of different protection coefficients and other tariff based measures over time. The impact study is in terms of econometrically estimating anti-export bias and efficiency of resource use in a reforming economy. The objective of the study is thus focussed. To understand the depth and coverage of the study, a broad overview of the chapters is necessary. While the first four chapters and the seventh chapter of the book are devoted to the former theme, the impact analysis is wrapped up in Chapters 5 and 6. Though trade reforms were initiated in the mid-eighties and made more comprehensive in the 1990s, Hasheem Nouroz prefers to restrict herself to the phase of comprehensive reforms. Accordingly, 1987- 88 and the years of the nineties are treated as pre-and post-reform years respectively throughout the book. However, the view that trade liberalization being initiated in 1991 is an extremely partial one!

The author provides an overview of the evolution of India's tariff regime and trends in nominal tariff rates across sectors in Chapter 1. It is observed that protection in terms of tariff rates have evolved to be high, the highest being on consumer goods during the sixties through the eighties. This is indeed a good starting point for the analysis that is taken up in the later chapters of the book. In these later chapters, the author provides estimates of various protection coefficients in order to show the extent to which the Indian manufacturing sector has been protected by tariff and non-tariff barriers during the pre-and post-reforms phases.

Apart from across-the-board reduction in tariff rates

and lowering of peak rates, the study finds that the structure of tariffs is significantly rationalized during reforms. Further, non-tariff barriers on imports are dismantled. The estimates of rates of protection, nominal and effective, across industries in the manufacturing sector show a steady decline. However, the effective rates continue to remain higher than the nominal ones through most of the period. For estimating ERP, the author has used methods alternate to that based on price comparisons by very correctly pointing out the difficulties in obtaining internationally comparable data on prices of manufactures. Each of the alternate measures, namely, simple average tariff rates, import-weighted tariff rates and collection rates contains information on different aspects of protection with true protection lying within the range of simple average tariff rates and collection rates. The structure of protection in Indian industry is found to very much depend on the choice of the tariff measure and the level and pattern of protection accorded to industries is thus ambiguous. Though difference between input tariffs and output tariffs have decreased significantly over time in all cases, the dispersion in NRP estimates based on various measures does not show an unambiguous decline.

Nonetheless, estimates of effective rates of protection based on simple average of tariff rates indicate that there has been a gradual reduction in the incidence of protection. Similarly, comparison of the collection rates shows that the difference in the pre-and post-reform years has considerably narrowed. It is also found that the ranking and level of protection changes when collection rates are adjusted for the overvaluation of the currency. The import weighted tariff rates for capital goods, intermediates and consumer goods also declined substantially during reforms. Import-weighted ERP estimates show a decline in protection during reforms along with a steady decline in NRP. The improvement in the Spearman's rank correlation coefficient between NRP and ERP post reforms is indicative of a fundamental change in the structure of protection. Despite reduction in protection and substantial changes in the ranking of industries with respect to protection coefficients, considerable inter- industry variation in ERP continues to exist.

Even if all the above findings suggest declining levels of protection and thus increasing efficiency of resource use, ERP is found to be the highest for exporting industries indicating a bias against export activity. Above all, even after substantial tariff reduction, Indian industries are found to enjoy a higher rate of protection as compared to other Asian countries. The inter-industry variation in India and Philippines are marked as compared to other Asian countries, namely Malaysia and Thailand. Further, the collection rates and tariff rates continue to have a weak relationship post reforms indicating the existence of widespread exemptions even after reforms. These findings have immense implications for the future directions of tariff policy in India.

The impact of declining import tariff on exports for the period 1980-81 to 1997-98 is studied using a three-sector model consisting of the importable, the exportable and the non-tradable sectors. In doing so, the study estimates an economy-wide measure of protection and the effects of declining protection of importables on exportables via non-tradeables. Time-series regression for the period 1982 to 1993 estimates the long run shift parameter to be at 0.75 per cent and the short-run one at 0.58 per cent. Despite limitations in the theoretical model and the methodology to derive the price indices for the three sectors, the results show that a 100 per cent rate of customs duty results in 'true' protection of importable only to the extent of 14.9 per cent in the long-run and a bias against exports to the extent of 42.5 per cent. In the long-run, thus, import protection via tariffs creates a significant bias against exports.

The study also treads into examining the impact of trade regimes on efficiency of resource use. For the purpose, the study estimates total factor productivity (TFP) growth for the period 1960-61 to 1988-89 using Cobb-Douglas production function. While examining the impact of trade regimes on total factor productivity growth, the impact exercise takes account of demand-side as well as supply constraints imposed by infrastructure and input bottlenecks. The Chenery measure of import substitution and export expansion variables has been used to capture trade regimes and the domestic demand variable has also been incorporated to examine its impact on total factor productivity growth. Estimation of the TFP growth rates for the period 1960-88 shows that the turnaround in productivity growth occurred in the mid-seventies. Regarding the impact of regime changes on TFP growth, the study could not "emphatically conclude" that import substitution has a negative impact on TFP and export expansion and domestic demand have a positive impact on TFP growth. The inclusion of domestic demand in the regression is of critical importance in case of Indian manufacturing and the regression results improve on account of that. Due to the use of imperfect measures of trade regimes, the results indicate that import substitution and export expansion do not have the desired impact on the productivity growth of Indian manufacturing. These results obviously add to the recent debate on productivity growth in Indian manufacturing.

On the whole, the book under review by Hasheem Nouroz is good and worth reading. Obviously, the

readership would not only include students and researchers in the subject, but the study is also bound to arouse lot of interest among policy makers. To policy makers, the book is very timely as it carries implications for the direction of change in the tariff regime. To me, the study has only two gaps to be fulfilled: the first is out of pure research interest and the second from a policy perspective. A simple partial equilibrium exercise on welfare implications of tariff reduction and a more detailed account of WTO induced market access for industrial goods would have further enhanced the work of this otherwise extremely useful study.

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Consumer and Quality *by D.B.N. Murthy,* New Age International (P) Limited, pages 232, Price Rs. 200.

The market dynamics has dramatically changed in past few years. Given the sensitivity of Indian consumers over quality and price, coupled with availability of reasonable alternatives for any product or service, producers are now on their toes to identify the customers' needs and expectations proactively to edge past the competitors. The market has become customer-pulled rather than producer-pushed. D.B.N. Murthy, in his book "Consumer and Quality", has thrown light on various aspects of qualities of products and services and the consumers at the appropriate time of market liberalization.

The author has elucidated his thoughts in seven logically arranged chapters. The book starts with importance of quality in chapter 1. The author has discussed the evolution of the concept of quality including its various interpretations in different contexts. Here, he emphasizes on the role of quality that influences the purchasing decisions of consumers. In chapter 2, he has described rights and responsibilities of consumers with suitable examples and explanations. He has discussed the choice making process of consumer and influences on it in chapter 3. He has touched upon subtler aspects of consumer choice making through consumer inducement including the traditional marketing tools like advertisement, etc. Then he has dealt with some practical aspects of product use including customer returned products, warranty, and product liabilities in chapter 4. Here, author has discussed at length, about the warranty of products with many suitable case examples. The author has explained complaint-redressing procedures in detail in chapter 5. He has taken relevant practical cases of customer complaints and complaint redresses. To illustrate the complaint redress process, he has presented a number of case studies showing how the consumer courts and other agencies have disposed of consumer complaints.

The role of consumers has been discussed at length in chapter 6 of this book. In addition to the producers' utmost effort to woo customers, he has made consumers aware of their responsibilities towards improvement of quality of products or services and other societal aspects. The final chapter deals with emerging trends in consumerism. The author has picked practices of developed world markets to extrapolate the upcoming trends in Indian market. In this chapter, he has predicted trends towards the dominance of service-oriented societies. He has indicated the enormity of alternatives of even complicated products and services in the coming future.

This book could have been more comprehensive, had the broader aspects of consumerism been covered. The scope of the book has been relatively narrowed within quality, consumer rights and responsibilities with little emphasis on proactive aspects on obtaining and exploiting customer perceptions for quality improvement and product innovations. Such practices are widely popular and already used in some of the progressive business sectors in India. Initiatives have been taken by the government through insisting on customer satisfaction measurement among the PSUs. Influx of MNC cultures has started inducing Indian business houses towards customer orientation. But within the defined boundary, the book has made appreciable endeavor to create awareness among consumers regarding the importance of quality, consumer rights, responsibilities and related aspects. In that light, the book will be very useful for the prospective reader cum consumers.

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Lodhi Road, New Delhi.

□

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