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Contents

Enhancing Creativity and Competitiveness through IPR in the Knowledge Economy

P.J. Philip & Rajender Kumar

Indian with its abundant pool of intellectual capital is favourably placed to be at the vanguard of nations in the emerging knowledge economy. But it has to work out effective strategies to manage its knowledge potential to enhance creativity and competitiveness. By putting in place a TRIPS-compliant IPR protection system, India has expressed its intent to exploit the potential of this system to spur economic growth and social development. Incorporating optimum utilization of IPR into knowledge management strategies will ensure India's place in the sun in the knowledge economy.

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The turn of the century has been a witness to human society transforming itself from Industrial Society to Knowledge Society. Military power and economic power, which ruled the roost in the previous century, are gradually giving way to 'brain power'. It is the ability of a nation to harness its brain power that will determine its place among the comity of nations in the 21st century. The product of brain power – knowledge – is increasingly acquiring the status of an indispensable asset that has the potential to accelerate growth. Generating, preserving and utilizing knowledge will, therefore, become the key to a vibrant economy in the coming years.

In the emerging scenario, a successful economy is one that uses knowledge as an effective tool for development. Creating and protecting knowledge, therefore, becomes vital. This underscores the significance of Intellectual Property Rights (IPR) that came into the limelight during the Uruguay Round of GATT, and found inclusion in the final agreement in the form of Trade Related Aspects of Intellectual Property Rights (TRIPS). India being a signatory to the agreement, was expected to set its house in order with respect to legislation and procedures, to comply with the requirement of the international IPR regime. During the ten-year transition period of 1995-2004, India struggled to get over its hesitation and doubts, but successfully met the deadline of December 31, 2004. Some people are still sceptical, but there is sample evidence that IPR can be a potent tool in accelerating the transformation of India into a knowledge power-house, which today has become essential to spurring economic growth and social development.

Objectives

This paper is an outcome of a study conducted with the following objectives:

- To identify the salient features of the evolving knowledge society
- To evaluate India's potential to develop into a knowledge economy
- To examine the role of IPR in enhancing creativity and competitiveness.
- To appraise India's preparedness to exploit the opportunities offered by the new IPR regime.

Knowledge Society

Man has traversed through different societies, each with its unique characteristics, to arrive at the threshold of what has come to be called the Knowledge Society. A superior intellect in comparison to other beings has contributed to man generating and disseminating knowledge, which in turn has triggered great inventions and innovations, accelerating the growth of human civilization. In the agrarian society, manual labour was the key factor and economic growth was linked to agricultural produce. The industrial revolution gave birth to the industrial society, which was driven by machines and technological development. The advent of the new millennium is a witness to knowledge occupying the centre stage and adding to the lexicon of new expressions like knowledge society, knowledge economy, knowledge worker etc. Knowledge becomes the most important resource, making acquisition, possession and application of knowledge of immense significance.

According to the management guru Peter F Drucker, knowledge society is a society that is characterized by borderlessness, and where knowledge instead of capital or labour is the primary factor of production. President Abdul Kalam identifies the following distinct characteristics of the knowledge society:-

- It uses knowledge through all its constituents and endeavours to empower and enrich its people.
- It uses knowledge as a powerful tool to drive societal transformation.
- It is a society committed to constant inventions and innovations.
- It has the capacity to generate, absorb, disseminate and protect knowledge and also use it to create economic wealth and social good for all its constituents.

The ability to create and maintain an infrastructure that facilitates knowledge creation and knowledge utilization will be the key to deciding the prosperity of the knowledge society.

India and the Knowledge Society

In the new millennium, efficient utilization of the knowledge resource can create comprehensive wealth for a nation and effectively contribute towards economic and social development. India is eminently endowed with all the vital ingredients to be in the vanguard of nations that can be benefited by knowledge society. India is home to one of the largest technical manpower pools in the world. It is rich in natural resources waiting to be harnessed. It has an ancient tradition of knowledge creation which got diluted by invasions and colonialization. India needs to reinvent itself to suit the requirements of the modern day knowledge society. As the developed world is moving over to a society where knowledge is the currency of power and wealth, India should leverage its assets and advantages to not only match the developed world, but move ahead and be the leader. Evidence that this is already happening is visible in the IT sector. There are more IT engineers in Bangalore than in the Silicon Valley, and most of the IT jobs in the USA today are held by Indians. Chances are that Indians could grab the jobs in other knowledge sectors as well. Bio-technology and pharmaceuticals are two sectors where India has started developing knowledge products. These products are making a mark for themselves not only domestically but even globally.

Knowledge Management Strategies

India is favourably placed to emerge as a leader in the knowledge society. But to attain this lofty position, it has to work out effective strategies to manage its knowledge potential to leverage economic and social development. Managing knowledge would entail creating an enabling ambience in the country for knowledge generation and knowledge protection. A system of protecting knowledge would act as an incentive for those engaged in knowledge generation. Assurance of protection and reward would invite more and more knowledge workers to involve themselves in creative thinking leading to inventions and innovations, ultimately resulting in upgraded technologies and social well being.

Knowledge Creation

To capture this unique opportunity to transform itself into a knowledge power, India has to consciously develop

Table 1: Expenditure on R&D (GERD) in billion US$ PPP and R&D intensity (GERD/GDP)

Region/Countries	1990		1992		1994		1996/97		1999/2000	
	GERD	GERD/ GDP	GERD	GERD/ GDP	GERD	GERD/ GDP	GERD	GERD/ GDP	GERD	GERD/ GDP
World Total	**409.8**	**1.8%**	**438.7**	**1.7%**	**478.5**	**1.5%**	**549.7**	**1.6%**	**755.1**	**1.7%**
Developed Countries	367.9	2.3%	379.7	2.3%	414.2	2.1%	460.4	2.2%	596.7	2.3%
Developing Countries	42.0	0.7%	59.0	0.6%	64.3	0.5%	89.3	0.6%	158.4	0.9%
Americas	**167.7**	**2.1%**	**186.7**	**2.1%**	**193.1**	**1.9%**	**225.8**	**2.0%**	**302.3**	**2.2%**
North America	156.4	2.6%	175.1	2.7%	178.1	2.5%	209.0	2.6%	281.0	2.7%
Latin America & Caribbean	11.3	0.5%	11.5	0.5%	15.0	0.5%	16.8	0.5%	21.3	0.6%
Europe	**138.8**	**1.8%**	**130.2**	**1.9%**	**147.7**	**1.6%**	**157.7**	**1.7%**	**202.9**	**1.7%**
European Union	101.9	2.0%	117.7	1.9%	128.6	1.8%	137.9	1.9%	174.7	1.9%
Central & Eastern	5.7	1.7%	2.9	1.5%	4.4	0.8%	5.6	0.8%	9.1	0.9%
Europe Community of Independent States (in Europe)	18.9	1.1%	4.1	0.8%	11.8	1.0%	7.6	0.9%	12.8	0.9%
Europe Free Trade Association	12.3	2.2%	5.5	2.3%	2.9	1.8%	6.6	2.3%	6.3	2.1%
Africa	**5.2**	**0.6%**	**3.6**	**0.4%**	**4.2**	**0.2%**	**4.3**	**0.3%**	**5.8**	**0.3%**
South Africa	2.9	1.0%	1.8	0.6%	1.8	0.6%	2.5	0.7%	3.6	0.8%
Other sub-Saharan Countries	1.9	0.5%	1.1	0.3%	0.5	0.1%	0.6	0.1%	1.1	0.2%
Arab States (in Africa)	0.4	0.3%	0.7	0.5%	1.9	0.2%	1.2	0.2%	1.1	0.2%
Asia	**94.2**	**1.8%**	**114.2**	**1.3%**	**127.5**	**1.1%**	**154.8**	**1.2%**	**235.6**	**1.5%**
Japan	67.0	3.1%	68.3	2.8%	80.0	2.8%	83.1	2.8%	98.2	2.9%
China	12.4	0.8%	22.2	0.7%	23.3	0.5%	21.1	0.6%	50.3	1.0%
Israel	1.8	2.5%	2.0	2.6%	2.4	2.7%	3.4	3.2%	6.1	4.7%
India	2.5	0.8%	7.1	0.8%	10.1	0.6%	13.2	0.6%	20.0	0.7%
Newly Industrialized Economics (in Asia)	8.2	1.6%	10.7	1.3%	7.3	0.9%	26.7	1.1%	48.2	1.7%
Community of Independent State (in Asia)							0.6	0.4%	0.6	0.3%
Arab States (in Asia)	1.9	0.4%	3.1	0.5%			0.8	0.1%	0.6	0.1%
Other Asia	0.5	0.2%	0.7	0.1%	4.4	0.3%	5.9	0.5%	11.6	1.1%
Oceania	**3.9**	**1.1%**	**4.1**	**1.2%**	**6.0**	**1.4%**	**7.2**	**1.6%**	**8.5**	**1.5%**

Source: UIs, regional estimations based on UIS data and UNESCO (1993, 1995, 1998), World Science Report, Paris, UNESCO Institute for Statistics (2001), The State of Science and Technology in the World, 19996-1997, Paris

a system of nurturing knowledge generation. It is through inventions and innovations that knowledge is converted into wealth. Further, innovation is a vital factor in enhancing competitiveness of both service and manufacturing sectors. Hence there is an urgent need to put in place a system that would involve a network of knowledge workers, knowledge-producing institutions and knowledge users. With such a network, the innovation system can tap into the growing stock of the global pool of knowledge, assimilate and adapt it to local needs and finally create new knowledge and technology. Evolving such a system would hasten India's growth into a global knowledge power. India has, today, more than 250 universities and many more professional colleges and institutions. We have the world's largest chain of publicly funded R&D institutions. On an average, more than 350,000 engineers and 5,000 Ph.D. scholars graduate every year. With such a vast reservoir of qualified, English-speaking scientific and technical manpower, India holds the potential to becoming an international hub of research and development activity.

Although the above figures, when considered in isolation present an impressive picture, they fade in com-

parison to global standards. Overall global trends in R&D have recorded an impressive growth as is evident in Table I. The world expenditure on R&D almost doubled from US $410 billion to US $755 billion in current purchasing power parities (PPPs), making it 1.7% of total GDP. But the percentage for developing countries is only 0.9%, which is less than the internationally prescribed target of 1%. Among the major countries of Asia, India is lagging behind. Asia as a whole spent 1.5% of GDP on R&D in 2000; Japan, 2.9%; China, 1% and India 0.7%. This clearly indicates that though the overall R&D expenditure of the country grew considerably over the decade, India continues to struggle to meet the 1% of GDP benchmark. R&D activities not only generate knowledge, but also utilize knowledge. If India has to emerge as a knowledge power, investments in R&D need to be considerably stepped up. India has to evolve a suitable strategy for building up knowledge networks in the country. Specific focus in this regard should be on the following:

- Publicly funded R&D institutions should be networked and nurtured as idea generators and providers of new concepts.
- These institutions should make a concerted effort to undergo a cultural shift by looking at research as a valuable input into business, and, hence, managing it in a business-like manner.
- A greater role should be played by the industry as partners who have the technical, financial and marketing strength to take ideas to the market place.
- Indian industry should transfer itself from an imitative mind-set to an innovative mind-set, and integrate R&D into their business strategy.

There are evidences that some of these initiatives are gradually being put in place. Positive results are starting to show in sectors like IT, pharmaceuticals and biotechnology. There is increasing recognition of India as an R&D hub. Many MNCs have evinced an interest in setting up their R&D centres in India. This augurs well for the country. Its future as a knowledge superpower seems a distinct possibility.

Knowledge Protection

Knowledge generation leading to wealth creation and societal transformation can be sustained only if knowledge is protected, and the knowledge creator is suitably rewarded. This is the rationale for evolving a system for protection of intellectual property which was brought into sharp focus by the Uruguay Round of GATT. The agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) lays down the intellectual property rights and their effective enforcement. The intellectual property system refers to the entire gambit of intellectual property laws, procedures, practices and institutions responsible for protecting, administering, enforcing and using intellectual assets for economic, cultural and social progress. India can be credited for recognizing the potential of IPR and taking the first steps, though unsure, towards systematizing knowledge protection. But the basic concept of IPR and its increasing contemporary relevance are issues that are still unknown to a vast majority of the Indian population, the educated elite included. This calls for a concerted effort to spread IPR literacy in the country.

Concept of IPR

Intellectual property refers to the creation of the human mind, of human intellect. In other words, intellectual property is a 'product of the mind'. The rights granted to the creators of innovative work are known as Intellectual Property Rights. The unauthorised use of intellectual property is an infringement of the right of the owner.

The convention establishing the World Intellectual Property Organisation, one of the specialised agencies of the United Nations, in 1967, provided that 'intellectual property' shall include rights relating to:-

- Literary, artistic, and scientific works
- Performance of performing artists, phonograms and broadcasts
- Inventions in all fields of human endeavour
- Scientific discoveries (no national law or international treaty gives any property rights to scientific discoveries)
- Industrial designs
- Protection against unfair competition and all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields.

Protection of Intellectual Property

The intellectual property is protected and governed by appropriate national legislation. National legislation specifically describes the inventions, which are the subject matter of protection, and those, which are excluded from protection. For example, methods of treatment of humans or animals by surgery or therapy, inventions

whose use would be contrary to law or morality, or inventions which are injurious to public health are excluded from patentability in the Indian legislation.

Intellectual Property Rights include:

- Patent
- Copyright
- Trademark
- Industrial design
- Geographical indications
- Trade secret
- Layout designs of integrated circuits

The different forms of intellectual property are as under:

Patent

Patents provide property rights to inventions. An invention may be defined as a novel idea, which permits in practice the solution of a specific problem. The TRIPS Agreement provides that for an invention to be registered as a patent, it must be:

- New
- Involve an inventive step, and
- Capable of industrial application.

The Agreement further stipulates that countries shall grant patents for inventions in all fields of technology and for both:

- Products, and
- Processes, including those used in manufacturing the products.

Further, patents are to be granted without discrimination as to place of invention and whether products are imported or locally produced.

The product/process which countries are permitted to exclude from patentability are:

- Diagnostic, therapeutic and surgical methods for the treatment of humans and animals
- Plants and animals other than micro-organisms
- Essentially biological processes for the production of plants
- Animals other than non-biological and microbiological processes.

However, where a country excludes plant varieties from patentability, it is expected to provide protection under a 'sui generis' system. The system provided by the UPOV Convention on the Protection of New Varieties of Plants can be used for this purpose.

Patents give patent owners exclusive property rights, allowing them to prevent others from using the inventions covered. Manufacturers wishing to use patented inventions must obtain licences or authorization from the patent owners, who normally will require them to pay royalties.

The term of a patent is that period for which a patent is valid in India. The term of a patent falling within the category of food, drug or medicine was five years from the date of grant or seven years from the date of filing. In respect of any other invention, the term of a patent was 14 years from the date of grant. With the latest amendments, the term of a patent is uniformly 20 years

Copyright

Rights known in general parlance as copyright can be acquired in relation to works of authorship that include literary works (this even includes computer software under the Indian law); musical works and accompanying lyrics; dramatic works and dialogues; pantomimes and choreographic work; pictorial, graphic and sculptural works inclusive of drawings, paintings, photographic works, architecture, works of applied art, maps, plans, sketches; motion pictures and other audio-visual works; and sound recordings. This right is basically a proprietary right and comes into existence as soon as the work is created.

In India, the right is protected by the Copyright Act of 1957, which was amended in 1984 and again revised in 1995 and 1999. Under the Act, registration of a work is not compulsory, i.e. there is no requirement of completion of any formality of registration. The particulars of the work can simply be entered in the Register of Copyrights to constitute prima facie evidence of ownership of work.

Copyright gives the proprietor exclusive right to make particular use of the work. The author also has a moral right to claim authorship, and either he/she or his/her legal heir can restrain or claim or hold damages in respect of any distortion, alteration or modification of the work, which would be prejudicial to his honour or reputation. The author is conferred exclusive right in respect of reproduction of the work and other acts, which enable the owner to get financial advantage by executing such rights.

Original literary, dramatic, musical or artistic work enjoy copyright protection for the lifetime of the author plus 60 years, if they are published within the lifetime of the author.

Trademark

A trademark is a visual system in the form of a word, a symbol or a label applied to an article of manufacture or sale with a view to indicating to the consumer the origin of manufacture. It, therefore, helps to distinguish such goods from similar goods manufactured by others in the same trade. Examples would include the service marks used by different companies to typify their brands like 'Parker' for pens, 'Lux' for soap, the Maruti logo etc.

The registration of trademarks is important because it creates a link between the manufacturer and the customer. The customer uses the trademark to choose goods while purchasing. The normal consumer would only be aware of such brand names associated with different items of consumption. When there are so many varieties of goods made by different manufacturers with varied features, it becomes possible to select one or the other, depending upon the relative feeling of trust associated with the various brands. It is also an excellent instrument of publicity and a symbol of goodwill, apart from being a property which can have an enormous economic potential.

In India, this protection is obtained through legislation covered under the Trade and Merchandise Act of 1958. As in the case of patents and designs, the trademarks are administered by the Controller General of Patents, Designs and Trademarks under the control and supervision of the Ministry of Industry.

The duration of a trademark is for a period of 7 years from the date of filing of the application. This period can be renewed from time to time for a period of 7 years from the date of expiry of original registration or subsequent renewal. Thus, a registered trademark can be kept in force perpetually by paying the prescribed renewal fees. This is followed because continuous use of the mark over a long period of time helps in making the mark popular amongst the customers, generating both publicity and goodwill.

Industrial Design

A design is an idea of conception relating to the features of shape, configuration, pattern or ornamental features applied to an article by any industrial process or means, whether manual, mechanical or chemical, separate or combined; which in the finished article appeals to and is judged solely by vision. It is clear that design means features of shape etc. applied to an article and not the article itself. These features are conceived in the creator's intellect. The ideas conceived are given material form as a pictorial illustration, or as a specimen, prototype or as a model. These features can then be protected as a design.

In India, designs are covered by the Designs Act of 1911. This act confers exclusive rights to apply to any article in any class in which the design is registered.

The registration of the design is possible only when it is reduced to a visible form so as to be identifiable. This can be either by being embedded in an actual article or by making a paper model or model of any other material or as a two dimensional model on paper.

Geographical Indications

Geographical indications are indications which identify a good as originating in a territory, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin. The TRIPS agreement provides that countries should not permit registration of trademarks containing a misleading indication of the geographical origin of goods. The most common example of this is 'champagne', a term associated with wine produced in a certain region of France. In principle, therefore, it is not permissible to call wine produced elsewhere 'champagne', even though the wine may be regarded in the producing country as comparable to the French champagne.

Undisclosed Information

Undisclosed information refers to trade secrets or know-how that has commercial value because it is secret, and that has been subjected to reasonable steps to keep it secret. The TRIPS agreement stipulates that a person lawfully in control of such information must have the possibility of preventing it from being disclosed or acquired by or used by others without his or her consent in a manner contrary to honest commercial practices. Furthermore, the Agreement has provisions on undisclosed test data and other data whose submission is required by governments 'as a condition of approving the marketing of pharmaceutical or of agricultural chemical products'. Member governments must protect such data against unfair commercial use.

Layout Designs of Integrated Circuits

The TRIPS agreement requires member countries to protect the layout-designs of integrated circuits in ac-

cordance with the Washington Treaty on Intellectual Property in Respect of Integrated Circuits (which was negotiated in 1989). Additional provisions stipulate that importing or selling articles incorporating a protected integrated circuit without authorization from the right holder shall be considered unlawful.

IPR-Related Legislation in India

Prior to the agreement on TRIPS, India had a legal system of protection for four types of intellectual properties viz.

- Patent
- Copyright
- Trade mark and
- Industrial design.

The TRIPS agreement brought in three additional intellectual properties viz, geographical indications, layout designs of integrated circuits and the protection of undisclosed information. During the ten-year transition period, India, through amendments and new legislation, put in place a legal system to comply with the requirements of the TRIPS Agreement.

The Current Status of Legislation

Patents: The Patents Act, 1970. The Act was last amended in 2005.

Design: The Design Act, 1911. A new Design Act. 2000 has been enacted, superseding the Design Act, 1911.

Trademarks: The Trade and Merchandise Marks Act, 1958. A new Trademarks Act, 1999 has been enacted, superseding the earlier Trade and Merchandise Marks Act, 1958.

Copyright: The Copyright Act, 1957, amended in 1983, 1984, 1992, 1994 and 1999 and the Copyright Rules, 1958.

Layout Design of Integrated Circuits: The Semiconductor Integrated Circuit Layout Design Act, 2000.

Protection of Undisclosed Information: No exclusive legislation exists, but the matter is generally covered under the Contract Law.

Geographical Indications: The Geographical Indication of Goods (Registration and Protection) Act, 1999.

The Task Ahead

If India is to compete with the developed countries, it needs to exploit its knowledge potential to leap-frog the technology lag. This challenge can be met if instead of getting bogged down in the avoidable details of the new IPR regime, India identifies the opportunities it offers and exploits them to its advantage. By legislating on all forms of IPR in compliance with the TRIPS agreement, laying down rules and procedures for their implementation and by modernizing all its IP offices and facilities, India has unambiguously expressed its intent to actively participate in the global IP system. To derive all possible advantages from this initiative, India has to undertake a number of proactive steps:

An intensive campaign to spread IPR awareness needs to be launched so as to energize potential inventors and innovators into creative activity.

An IPR culture needs to be deliberately promoted to encourage innovative activity linked to technological development and competitive advantage.

IPR and public interest are not antithetical to each other as it is made out to be. IPR is only a limited monopoly with the ultimate benefit accruing to the society. Whatever concerns are there regarding adequate safeguards should appropriately be addressed at the national level.

An R&D network capable of creating, organizing and disseminating knowledge and also converting knowledge into economic and social goods be put in place. It should be a collaborative effort in public and private partnership. Although India has set out on a course of privatization, it has to be realized that without government action there will be little investment in the production and adoption of new technologies.

In a country so richly endowed with traditional knowledge, adequate protection should be ensured to exclude unauthorized use of this knowledge by third parties. At the same time, efforts should be made to further develop traditional knowledge so as to enhance its role in local and national development.

As India sets its agenda for the 21st century, it has to be realized that a nation's ability to convert knowledge into wealth through creativity and innovation will provide the competitive edge and determine its future in the knowl-

edge century. An understanding of the role of IPR in the process of innovation and the role of innovation itself in the process of development is crucial to India developing itself into a knowledge economy. The knowledge management strategies of India, therefore, will have to incorporate optimum utilization of IPR.

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We'll be known as the helpful store. The friendly store, the store with a heart. The store that places public service ahead of profit. And, consequently, we'll make more profits than ever before.

– George Seaton

Knowledge Management in E-governance: Ten Guiding Principles

D.C. Misra

Knowledge management is a distinct contribution of the private sector, and has only recently started making an entry into the public sector. In this paper the importance of e-government is described, five popular myths of knowledge management are exploded and, ten guiding principles for the introduction of knowledge management (KM) in e-government are proposed. It is observed that it is essential to prepare an e-business plan for a quicker, smoother and more sustainable e-governance for increased productivity in developing economies.

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Knowledge management, popularly known by its acronym KM, is only 5 to 15 years old, and is a distinct contribution of the private sector where the concepts of knowledge as a "competitive advantage of the firm" and "knowledge capital" hold sway. Its pioneers include Peter Drucker, who coined the term *knowledge worker* in 1970s, Karl-Erik Syeiby, who came out with *knowledge management activity planning* (KMAP) in 1980s and Nonaka and Takeuchi who popularized the concept of *tacit knowledge* in the 1990s.

It is only recently that knowledge management (KM) has started making an entry into the public sector. In the United Kingdom, for example, e-envoy whose office was set up in 1999 and replaced by the e-government unit in 2004, introduced the knowledge network in 2000 followed by knowledge enhanced government (KEG). A development agency like the World Bank also set up a knowledge management secretariat and has come out with a knowledge assessment methodology (KAM). One of the important reasons for this development has been the emergence of information and communication technologies (ICTs) in the last decade.

The use of the term *knowledge management*, however, is far from happy. As noted by Von Krogh, Ichijo and Nonaka (2000), 'In fact, the term *management* implies control of processes that may be inherently uncontrollable or, at least, stifled by heavy-handed direction.' They, therefore prefer the term *knowledge enabling* - the overall set of organizational activities that positively affect knowledge creation.

Rise of Knowledge Worker and Knowledge Economy

The knowledge worker has emerged as a *key* resource for accelerated economic development. India has taken the unique initiative among developing

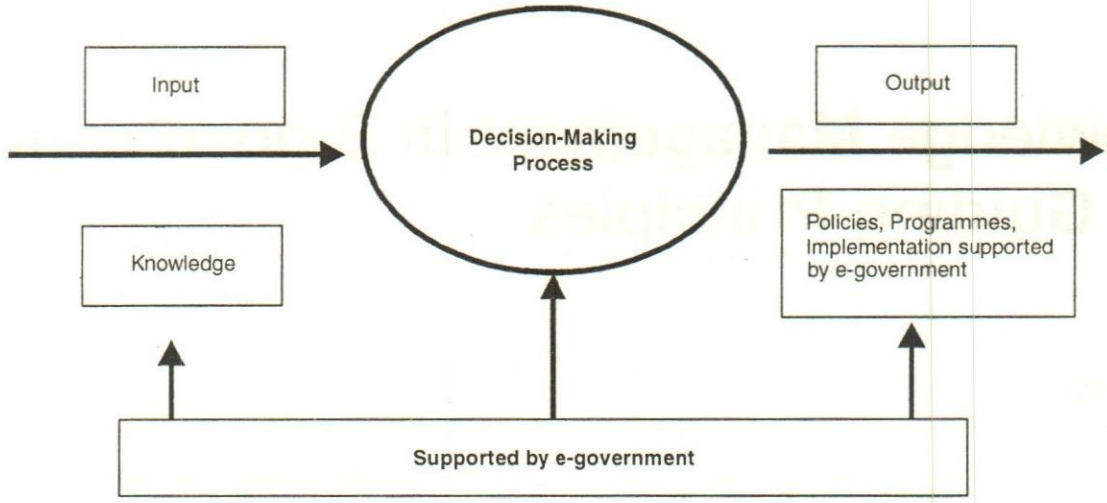

Fig. 1. The decision-making process in government supported by e-government

economies of setting up a National Knowledge Commission for leveraging knowledge for economic development (Misra, 2006). The emergence of Finland as a leading knowledge economy, from a country that was earlier facing an economic crisis, is a success story of leveraging knowledge for economic development.

Information and communication technologies (ICTs) and e-government play an important part in leveraging knowledge for economic development. An attempt is made in this paper, after a brief overview of the field, to suggest ten guiding principles for the introduction of knowledge management (KM) in e-government for increased productivity in developing economies.

What is Knowledge Management (KM) for e-government?

At the macro level knowledge management (KM) may be defined as the leveraging of knowledge for attaining objectives of productivity and competitiveness of a national economy. At the level of a government, knowledge management (KM) for government (KM4G) may be defined as leveraging knowledge for improving internal processes, for formulation of sound government policies and programmes and for efficient public service delivery for increased productivity. Finally, knowledge management (KM) for e-government (KM4Eg) may be defined as management of knowledge for and by e-government for increased productivity. KM4Eg is a management tool for government decision makers and its programme implementers.

The Government has been the principal user of knowledge since time immemorial. The primary function of the government is decision-making and e-government provides unique support to this (Fig. 1). The government also has the largest repositories of information and databases and e-government helps in their efficient management. The Government has always had access to the best available technology of the day to manage its affairs and e-government provides some of the latest and best available technology. There has also been an information explosion in recent years and e-government provides an important tool to cope with this. Office documents lead in storage on paper (Table 1), and the need for a *paperless office* is an important promise of e-government.

Information and Communication Technologies (ICTs), E-government and Productivity

Solow's remark, made 20 years ago, that, "You can see the computer age everywhere but in the productivity statistics" (Solow, 1987) still holds true. However, "There is now persuasive evidence that the information and computer technology (ICT) investment boom of the 1990s has led to significant changes in the absolute and relative productivity performance of firms, sectors and countries" (Hughes and Morton, 2005).

Corsi et al. (2006), in a study commissioned by the European Commission for the e-government unit, note that, "Given the large share of PS (public sector) in European countries' GDP, efficiency in PAs (public administration) is an objective per se and a major driver of international competitiveness and economic welfare." According to them, e-government enhances GDP growth through four channels:-

(i) growth of PS productivity

(ii) growth of PS total output

(iii) efficiency of public administration (contributes directly to the efficiency of the economy as a whole and to the productivity of the private sector in particular)

(iv) as part of aggregate demand.

They estimate the overall GDP growth attributable to e-government in the period 2005-2010 in the European Union at 2%.

Importance of Knowledge Management (KM) for e-Government (KM4Eg)

Print, film, magnetic, and optical storage media produced about 5 exabytes of new information in 2002 (SIMS 2003) (1 exabyte = 10^{18} bytes). 92% of the new information was stored on magnetic media, mostly in *hard disks*. Film represents 7% of the total, paper 0.01%, and optical media 0.002%. Almost 800 MB of recorded information is produced per person each year. Governments, therefore, face an information explosion and KM4Eg can help governments in coping with this, leading to better policy formulation, better programme implementation and need-based skill formation for increased productivity. KM4Eg is no longer a choice but an imperative if economies have to survive in the unfolding era of privatisation, liberalisation and globalisation.

Table 1: Worldwide production of printed original content: Storage content: Paper

S.No.	Type of Content	Terabytes
1	Books	39
2	Newspapers	138.4
3	Office Documents	1,397.5
4	Mass market periodicals	52
5	Journals	6
6	Newsletters	0.9
7	Total	1,633.8

Source: How much information 2003 (SIMS 2003)

KM4Eg may be viewed from a variety of perspectives, for example, process perspective, user perspective, technical perspective, organizational perspective, legal perspective, knowledge perspective, cultural, societal and political perspective (Wimmer, 2002).

Exploding Five Myths in Knowledge Management for e-government

Myth 1: KM is a fad.

Wrong

It is here to stay whether we call it by this or any other name.

Myth 2: KM is not for government

Wrong

Government being knowledge-based, it is very much for the government.

Myth 3: KM is not for civil servants

Wrong

Being knowledge workers, civil servants are very much concerned with *KM*.

Myth 4: KM is not for e-government champions

Wrong

KM being an integral part of e-government, e-government champions, whether politicians or civil servants, are vitally concerned with it.

Myth 5: KM is theoretical discipline.

Wrong

It is a practical management tool, which has tremendous potential for increased productivity and competitiveness.

Issues in Knowledge Management for e-government

A number of issues, some old and some new, have arisen with regard to knowledge management for and by e-government in the government, for example:-

(i) information is not up to date

(ii) required information is not available

(iii) too much information is collected

(iv) very little information is used in actual decision-making

(v) there has been an information explosion and

(vi) new areas like information and communication technology (ICT) and e-government have emerged calling for collection of new information.

Knowledge Pyramid for e-government

Knowledge pyramid is frequently used by knowledge management (KM) scholars (see, for example, Cong and Pandya, 2004). Knowledge management (KM) for e-government has four components of:-

(a) data, which consists of facts and figures

(b) information, which is interpreted data (data + interpretation)

(c) knowledge, which is use of information (data + interpretation + use)

(d) wisdom, which is application of knowledge (data + interpretation + use + application) as shown in Figure 2. Note that wisdom, defined here as application of knowledge, and not knowledge per se, is the highest form of knowledge.

Types of Knowledge

Knowledge is of different types, for example old and new knowledge. Similarly, there is network knowledge. Then there is the familiar classification of explicit and tacit knowledge. There is yet another classification of inexpressible, expressible and expressed knowledge. Among these, tacit knowledge is more important than explicit knowledge as experience indicates that actual decision making in government is based on tacit and not on explicit knowledge. For example, two civil servants can interpret a rule in two different ways. Then there is the widely quoted observation of Polyani (1966) that we can know more than we can tell (emphasis original). Thus knowledge exists in great variety, making the task of its capture, storage, retrieval and use in governments (and for that matter in any organisation) a challenging task.

Sources of Knowledge in Government

There are a number of sources of knowledge in government, for example:-

(a) ministers (b) legislators (c) civil servants (d) documents - files, agenda, records of proceedings, minutes, government orders (GOs), notifications (e) laws, rules and regulations (f) archives (g) embedded in physical systems (h) citizens and non-citizens (say, tourists). These sources are not only widely dispersed but also exhibit a great variety in content.

Locating Knowledge

Knowledge can be kept in 4Ps:

i) places – recorded in existing document or database

ii) processes – embedded in known work process

iii) people – known to an identified individual

iv) pieces – distributed in parts among several people or processes (as in a value chain) (Curley and Kivowitz, 2001).

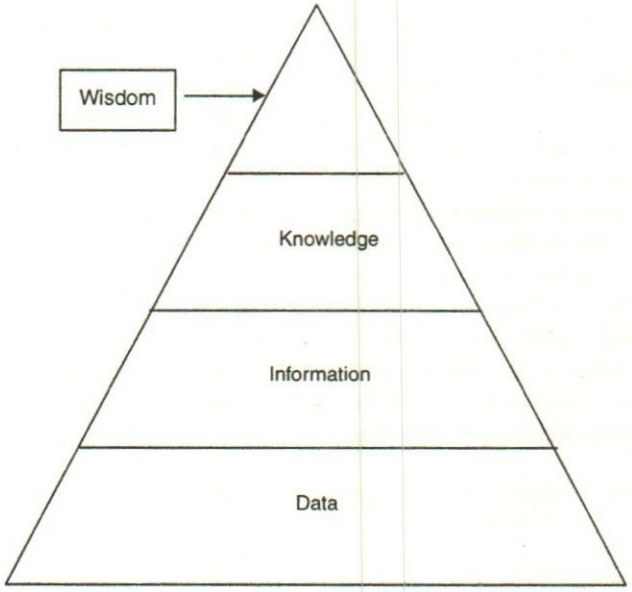

Fig. 2. Knowledge Pyramid in e-government

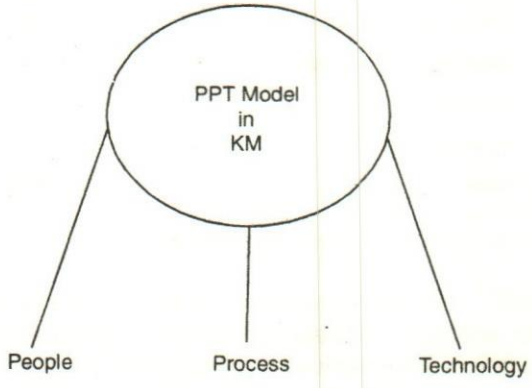

Fig. 3. The People, Process and Technology Model in Knowledge Management

Dimensions of Knowledge Management

There are three dimensions of knowledge management (KM):-

(i) people (P) - values and behaviour

(ii) process (P) - Internal structures

(iii) technology (T) - enabler (KM"T). It is a 3-legged stool. If one leg breaks, the stool falls down (Fig. 3).

Knowledge Management (KM) toolbox for e-government

A number of knowledge management (KM) tools and techniques exist for e-government. For example:-

1. After Action Reviews (AARs) - Pioneered by the U.S. Army for learning lessons from an activity or project
2. Communities of Practice (COPs) - killer app of KM for sharing of knowledge
3. Knowledge Audit - A systematic process to identify an organisation's knowledge needs, resources and flows, as a basis for understanding where and how knowledge can add value (de Brun, 2005). Also comparison of performance against pre-set standards
4. Knowledge Plan - based on knowledge strategy
5. Exit Interviews - capturing knowledge of departing employees
6. Sharing Best Practices – identifying and capturing in one part of the organisation and sharing with all others
7. Knowledge Centres - connecting people, information, databases
8. Knowledge Harvesting - capturing knowledge of "experts" and making it available to others
9. Peer Assists - learning from the experience of others before undertaking an activity or project
10. Social Network Analysis - understanding relationships between people, groups and organisations to see how they facilitate or impede the flow of knowledge
11. Storytelling - ancient art of sharing knowledge still widely used
12. White Pages - preparing a directory of experts (De Brün, 2005).

Knowledge Management and Technology

Knowledge management (KM) and technology today have become two sides of the same coin. Developments in these two fields are reinforcing each other. The four most popular types of knowledge management projects involve the implementation of intranets, data warehouses, decision support tools, and groupware (Ruggles, 1998, reporting on a 1997 survey, as quoted by Hislop, 2005). It has become inconceivable to think of one without the other. A number of functionalities in knowledge management (KM) are being helped by information and communication technologies (ICTs) (Table 2).

Table 2: Knowledge Management and Technology

S. No.	Functionality	Information and Communication Technologies (ICTs)
1	Searching	Search Engines
2	Categorising	Computer Languages (XML, RDF)
3	Composing	Office Suite Applications
4	Summarising	Artificial Intelligence
5	Storing	Storage Media
6	Distributing	Networks
7	Workflow	Groupware
8	Content Management	Content Management Systems
9	Customer Relationship	Customer Relationship Management (CRM) Software
10	Metadata Standards and Interoperability	Semantic Web Technologies

Source: Based on Riley 2003, Wagner et al. 2003 and Klishewski and Jeenicke, 2004

Knowledge Management Cycle

KM can be viewed as a cycle consisting of six successive phases: Undertake Knowledge Audit; Create Knowledge; Capture Knowledge; Store Knowledge; Use Knowledge; and Review Knowledge.

Phase I: Undertake Knowledge Audit

Ask questions like: Who collects what information? Why is it collected? Is it collected on time? Is collected knowledge put to any use? Is there a better way of collecting knowledge? Is required information being collected?

Phase II: Create Knowledge

Take stock of existing knowledge. Assess knowledge needs of the organization. Determine who will create what

information, when and in what format. Use knowledge management (KM) tools for knowledge creation.

Phase III: Capture Knowledge

Transform tacit knowledge into storable explicit knowledge (Neve, 2003). Record one-to-one conversations. Record a brainstorming session. Record minutes of the meetings and other proceedings. Record success profile of individual e-government champions.

Phase IV: Store Knowledge

Organize knowledge into codifiable and non-codifiable categories (Warren et al, 2006). Use electronic media for knowledge storage. Open a knowledge centre in the ministry/department. Identify and use "best practices" in knowledge storage.

Phase V: Use Knowledge

Knowledge captured and stored should be made accessible to all concerned personnel. Distribute and share knowledge. Set up knowledge distribution and knowledge sharing mechanisms. Provide knowledge inputs to policy makers. Monitor knowledge use

Phase VI: Review Knowledge

Scan the horizon to anticipate knowledge needs of ministry/department. Review the existing stock and flow of knowledge. Make use of simple but effective knowledge indicators. Involve stakeholders in knowledge review. Has knowledge led to better decision making and/or higher productivity? The knowledge management cycle may be seen in Figure 4.

Ten Guiding Principles for introduction of knowledge management (KM) in e-government

Guiding Principle 1: Develop a knowledge management (KM) strategy for the organisation. Leverage knowledge for achieving organisational goals and serving citizens and non-citizens.

Guiding Principle 2: Proceed step-wise, from simple to the complicated. Adopt modular approach. Do not attempt anything highly ambitious in the initial stages.

Guiding Principle 3: Do not re-invent the wheel. Make use of existing knowledge and insights. Undertake knowledge needs assessment. Only then plan the next step.

Guiding Principle 4: Make use of information and communication technologies (ICTs). But do not forget GIGO (garbage in and garbage out).

Guiding Principle 5: Make use of people, process and technology (PPT) model. But do not forget: Computers are fast, accurate, dumb; People are slow, sloppy, smart.

Guiding Principle 6: Prepare a simple and modular knowledge sub-plan incorporating knowledge management (KM) strategy. Do not use any complicated knowledge management (KM) tool or mechanism that cannot be successfully implemented.

Guiding Principle 7: Include knowledge management (KM) sub-plan in the e-business plan of Ministry/Department. Do not prepare any stand-alone knowledge management (KM) sub-plan. It is more likely to fail than succeed.

Guiding Principle 8: Secure top management support to knowledge management (KM) sub-plan. Remember, no plan can succeed without top management buy-in. This has to be a priority.

Guiding Principle 9: Demonstrate results. Remember, the best way to convince any one about practical utility of knowledge management (KM) is to show concrete, verifiable results.

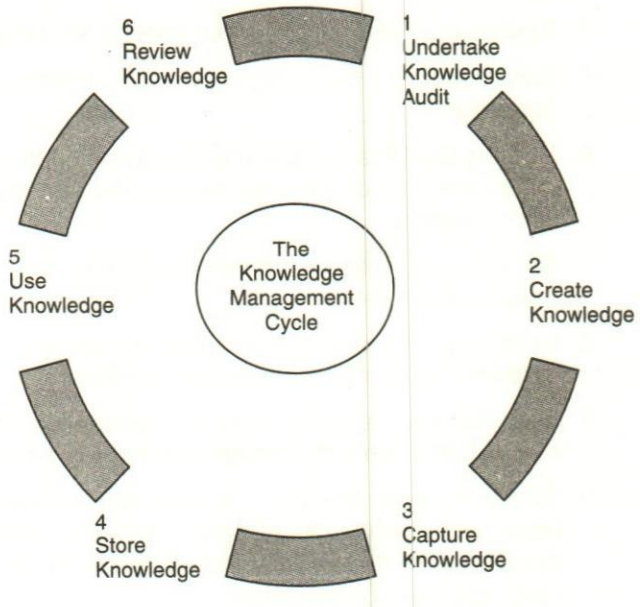

Fig. 4. The Knowledge Management Cycle

Guiding Principle 10: Review the implementation of the knowledge management (KM) sub-plan from time to time.

Review the implementation of the knowledge management (KM) sub-plan against the following three criteria: Has the implementation of the knowledge management (KM) sub-plan resulted in:-

(a) better decision-making by the government

(b) better service delivery to citizens and non-citizens

(c) better performance by civil service.

Conclusion

To conclude, the current e-government practice in developing economies is project-specific and not government-wide, with the consequence that e-government impact often fizzles out at the level of a project and is not felt at the government level where decision-makers usually operate. A comprehensive government-wide approach to e-government is called for. For ushering in e-government in developing economies it is essential to prepare a comprehensive e-business plan, for improving internal government processes and providing improved public service delivery to citizens and non-citizens, incorporating among other among other sub-plans, a knowledge management (KM) sub-plan together with a change management (KM) sub-plan, for quicker, smooth and sustainable e-government for increased productivity in developing economies.

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Before printing was discovered, a century was equal to a thousand years.

– Henry David Thoreau

Knowledge Management – An imperative for Enterprise Empowerment for Enhancement of Stakeholders' Value

K. Kalaiselvan & G. Ganapathiraman

Owing to globalization, economic growth and evolution in electronics, the business process outlook is continuously shifting its horizon. Knowledge-driven business enterprises are focusing on 'survival activities' by operational excellence and 'advancement activities' through innovation for competitiveness and balance between these two for growth. This paper focuses on the global business environment and gives an overview of the Knowledge Management (KM) life cycle process and perspectives.

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Global Business Environment

Accelerated economic growth of emerging Asia has reflected high trade growth and increased trade integration and greater business cycle correlation across countries. Exports between countries continue to play an important role in growth of emerging Asia. The intraregional trade has raised sharply through vertical integration and geographical dispersion of production process. In India, the economic growth has accelerated due to liberalization, global outsourcing of customer support services on export, cyclical and temporary factors such as good monsoon, rains for agricultural production, the impact of low income rates on consumer and real estate credit etc. This rapid economic growth has also led to large-scale change in business environment with respect to trade pattern, consumption, requirement of resources, employee turnover, and eventually outsourcing and economic overheating.

On the other hand, the current business outlook has changed from 'customer delight' to 'customer successes'. Customer perspectives for the products and services also are continuously changing. Currently, consumers are demanding products and services that have superior technology, world-class quality, lowest cost, user friendly and maintenance-free products while ensuring the intended use. Buying decision is primarily governed by one or more criteria such as shorter delivery and/or project completion schedule, best service capability and fast response, lower total life cost (for a period over 20 years for high end industrial equipment), single point contact, joint working, stern commercial terms and conditions with high penalties on deviations etc. Consumers' demand has increased as they are educated and knowledgeable on products and services through

several media. Such consumers are known as 'prosumers' in today's competitive market.

In the above prevailing scenario, large Multi National Companies (MNC) from the advanced countries have improvised their operation and infused methods to combat acute global competition with fast response, greater technical, financial and strategic muscle. Over a period, these MNCs have been building organizational capability by evolving business transformation processes through several methods starting from 'Productivity and Quality' (1977); 'System, Quality and Process improvement'; 'Benchmarking and Best Practices', 'Transfer of Best Practices' and 'Knowledge Management' (1998 onwards). 'Knowledge Management' is an interdisciplinary business model, which is emerged from the current technological revolution that is disrupting the existing organizational structures and dynamics. 'Knowledge Management' reaps great value in terms of competitive advantage to the organization for its sustenance and growth.

MNCs have been marshalling their resources for 'Knowledge Management' to build capability by consolidation while emphasizing on their core competencies, identification of knowledge gap/road blocks, measures for prevention of knowledge loss, knowledge creation, continuous product and process innovation, knowledge retention, knowledge dispersion within group and among groups known as community, shared business intelligence - collaboration, people retention - preserving expertise turnover, risk management, and productivity enhancement. MNCs provide total solution by building capability for engineering, procurement and construction, renovation and modernization, and services. Seamless progression is being made by MNCs in operational excellence for regular release of new product with added value and product differentiation by adapting the concepts of usage of 'standard parts', 'build to order and mass customization', 'design-out maintenance' and 'design to cost'.

Such organizational learning nurtured these MNCs with competitive intelligence and they now matured to adopt the concept of 'design anywhere', 'build anywhere' and 'maintain anywhere at any time' so that they can quickly respond to customers and emerging new markets globally by rapid development of new products and services with dominating technologies. From these emerging capabilities, knowledge driven companies are able to convert their corporate business strategies into the desired performance as reality.

Overview of Knowledge Management

Knowledge is elicited from information and Data as shown in fig.1. Data is a quantitative capture of facts. Data becomes information when data is classified and organized in a required format. Information is more qualitative than quantitative. Knowledge is the insights, understanding gained through experience and practical know-how that is known. Wisdom is the ability to see beyond the horizon.

Knowledge is classified and captured according to the type of knowledge useful to the organization. Overview of knowledge types are summarized below:

(a) Shallow and deep knowledge: Shallow knowledge is a surface level or minimal level understanding of an aspect or a problem. Deep knowledge is acquired through experience and required for decision-making.

(b) Knowledge as know-how: Practical experience expressed as heuristics and used for building expert systems.

  (i) Reasoning by analogy – relating one concept to another

  (ii) Formal reasoning – Deductive reasoning deals with exact facts and conclusion in the form of IF/THEN statements. Inductive reasoning from a set of facts to general rules.

  (iii) Case-based reasoning (CBR)

(c) Common sense as knowledge: Collection of personal experiences and facts acquired over time.

(d) Procedural knowledge: Understanding of how to do a task through documented procedures

(e) Declarative knowledge or awareness knowledge: Information discussed by expert

(f) Semantic knowledge: Highly organized, 'chunked' knowledge resides in long-term memory e.g: major concepts, facts, vocabulary and relationships

(g) Episodic knowledge: Experiential information or episodes chunked in long term memory. Its use is generally automated. Special tools are required to capture this.

Another approach was evolved as knowledge categorization by Nonaka and Takeuchi in 1995 such as 'tacit knowledge' and 'explicit knowledge'.

Tacit knowledge

Individual internalized knowledge gained from education, experience and context specific expertise. Tacit

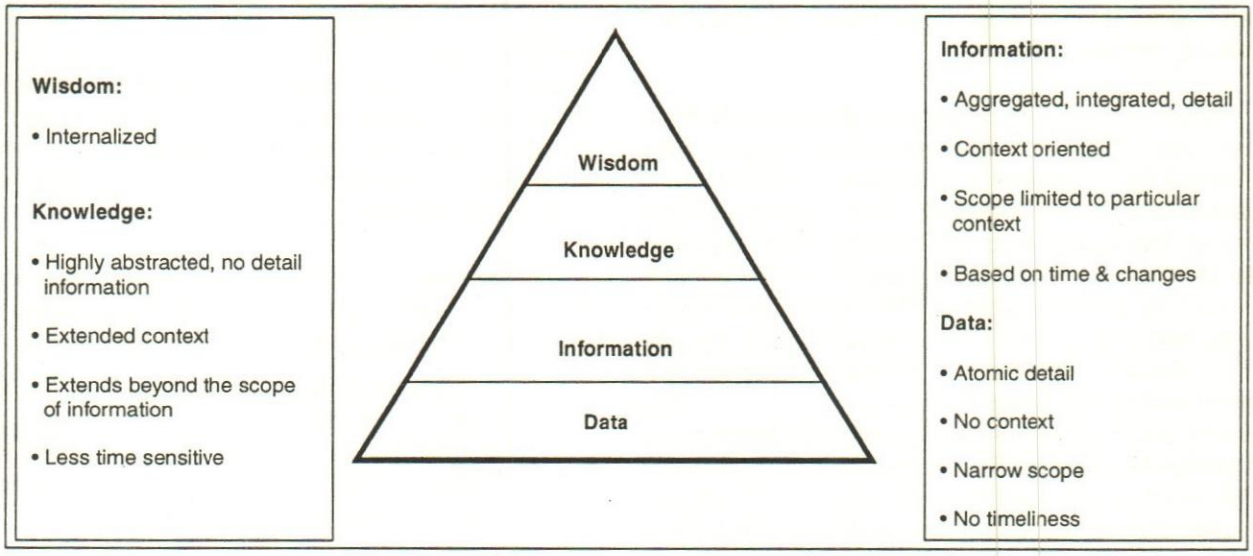


Fig. 1. Data, information, knowledge & wisdom

knowledge is what is in our heads or learn by doing or knowing-how, or embodied knowledge used for decision or judgment without going through any rule or procedures. Tacit knowledge is mindsets (or mental models) of individuals, intuitions, perspectives, beliefs, values that result from experience, and the collective mindsets of an organizational culture. It can best be communicated interpersonally through dialogue with use of metaphors. Michale Polanyi (1891-1976) developed the concept 'tacit knowledge' that includes intuition, values, and belief gained from years of experience. Tacit knowledge is difficult to capture fully and formalize for sharing. Tacit knowledge is vulnerable to loss as it is stored in the individual mind, but reduced when captured and shared. After capturing and sharing, it is easier to re-use.

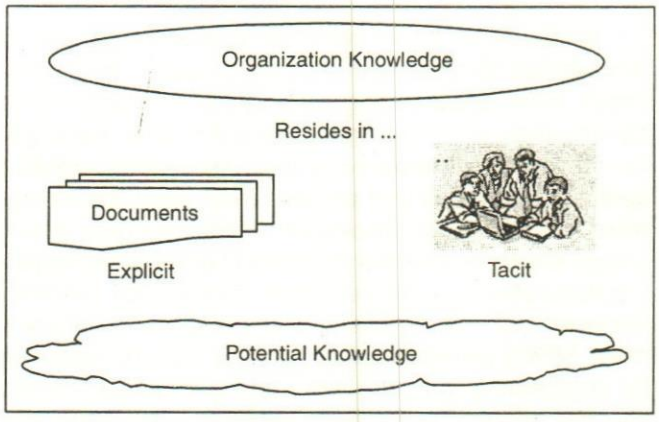


Fig. 2. Company knowledge

Explicit knowledge

Knowledge the individual holds explicitly. Explicit knowledge is what we have articulated or can be articulated, codified and stored in media such as manuals, Reports, training courses, white papers, documents, procedures, audio-visual, embedded knowledge in knowledge base etc,. Explicit rules or procedures or any other kind are referred or 'knowing-that' for decision or judgment. Explicit knowledge can be easily identified, retrieved, measured, re-used, transmitted and distributed. Thus, the organizational knowledge is available in the form of 'explicit knowledge' and 'tacit knowledge' as shown in Fig 2. These knowledges are pertaining to product knowledge, process knowledge and service knowledge and are available in individual, group(s), function(s), strategic business unit and corporate as shown in Fig 4.

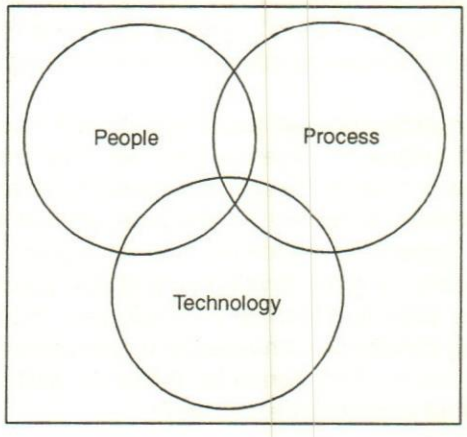


Fig. 3. Knowledge Management

Knowledge Management perspective

Knowledge Management engages People, Process and Technology in tandem (shown in Fig. 3) to proliferate knowledge, to improve organizational efficiency, responsiveness, competency innovation, and drives the organization forward. People represent knowledge workers, managers, customers and suppliers. Process represents knowledge centers where knowledge is available for capture and aid in identifying individual expert or expert teams within the center. e.g Marketing, Sales, Engineering, Production, Human Resource, Customer service etc,. Technology represents the totality of hardware and software required to leverage knowledge and use. Speed, security, volume or size, compatibility, integrity, accuracy, availability, reliability and maintainability are all expected attributes of technology. Technology enables knowledge delivery. The existing knowledge to be identified classified and codified in useable form. Identify knowledge gap and develop methods to create new knowledge. Knowledge is leveraged, transformed, built, run and this cycle continues. Knowledge Management comprises several interlacing key aspects and processes to achieve the following milestones.

(a) Identify, capture, classify, apply and embed product-process-service knowledge. Aid in building corporate memory by capturing product and process expertise, decision rationale, achievements and failures, tangible value, intangible value etc,.

(b) Nurturing new knowledge, stimulating and managing organizational innovation in unprecedented ways.

(c) Represent in knowledge base for Electronic Content Management, documents and expert systems as needed.

(d) Use accessible knowledge from internal and external sources and facilitate

(e) Organizational learning through value networks. Empowers organization to understand the environment and adapt accordingly.

(f) Build organizations, Intellectual capital such as 'human capital' – people Knowledge, 'structural capital'–patents, trademarks, databases and 'relationship capital' – learning from customers and stakeholders.

(g) Establish knowledge neural networks and facilitate knowledge transfer among communities. Knowledge sharing ensures faster processing, prevent effort duplication, successful partnering with vendors/customers etc,.

(h) Reuse of knowledge wherever applicable in the business

(i) Promoting knowledge accumulation and reinforcement of systems and culture by policies and incentives.

(j) Maintain and improve the knowledge acquisition and dissemination system.

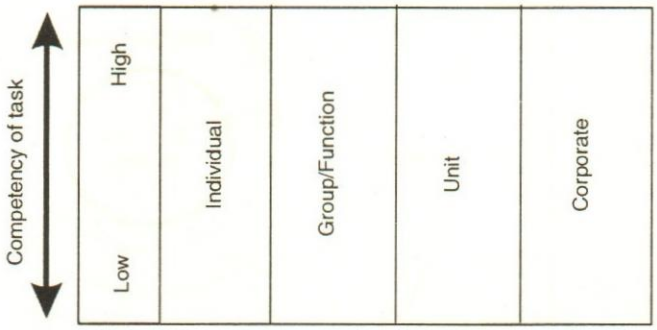


Fig. 4. Knowledge centers

All these Knowledge Management process elements proliferate business knowledge that enable organization gain competitive advantage through faster learning, better customer experience, shorter new product development cycle, greater innovation by leveraging the expertise across the organization and wider productive connections between employees.

'Personal Knowledge Management' is a yet another concept emerging out of Knowledge Management, Personal Information Management and cognitive human abilities. It focuses on individual learning of knowledge workers through 'personal enquiry' and connects to acquire knowledge.

Knowledge Management process is best accomplished when the collective effort of individuals in a group are bound by common purpose with active participation in creation and management of knowledge of products and services they are involved with. This shared business knowledge is available for all members of this community. And also, this can be accessed and collaborated by other communities, if needed to find solutions and build innovations. More such community of practices enables organization to enrich the knowledge base for use, reuse and preservation.

Understand from a survey report that individual learning is limited to about 31% and the remaining 69% learning comes by accessing others. Knowledge is

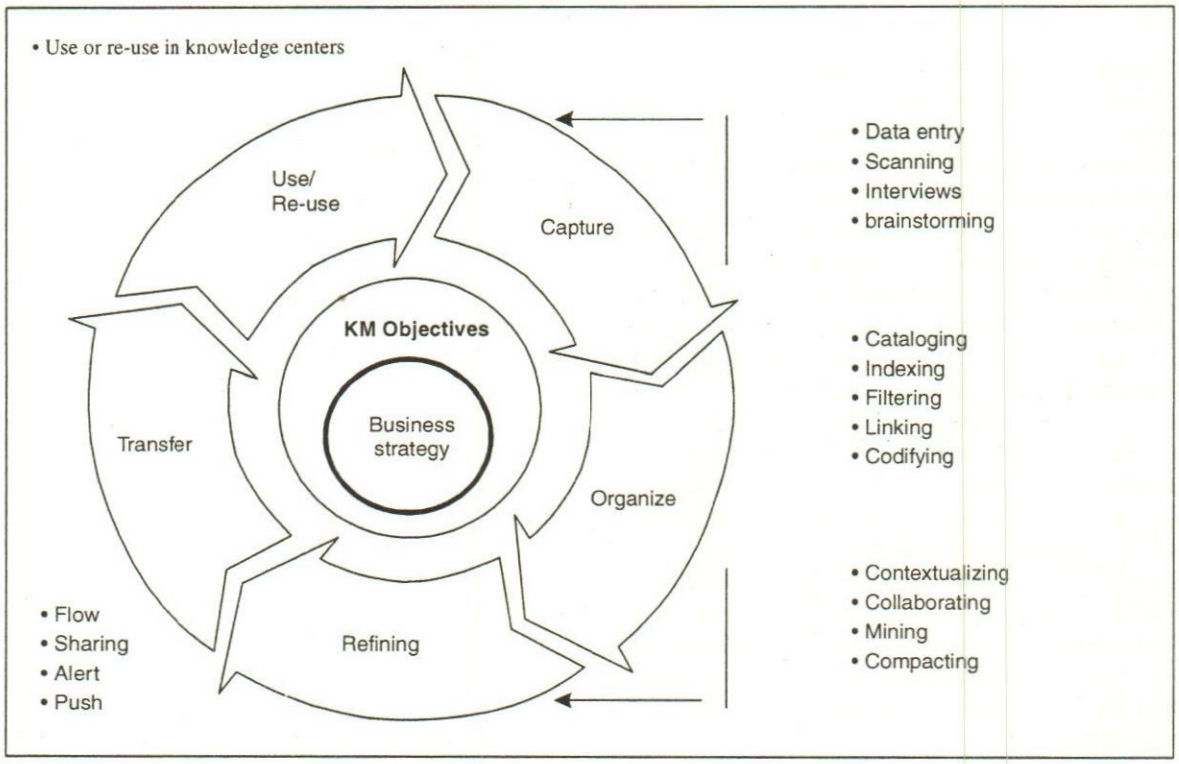


Fig. 5. Knowledge Management Life cycle

captured and leveraged through continuous organizational learning process eg. Lessons could be learnt not only from old mistakes but also from communicated mistakes.

Knowledge Management Life cycle process

Building of Knowledge Management is viewed as a life cycle that encompasses review of existing knowledge and planning, cost-benefit analysis and justification, and determining the hardware and software for structure to knowledge requirements of the organization. Identification of immediate, intermediate and long-term requirements of prospective Knowledge Management system is essential. Well-defined life cycle is paramount for successful development of knowledge management system.

Knowledge Management Life cycle begins with knowledge capturing, followed by knowledge organization, knowledge refinement, knowledge transfers, and use or re-use as shown in Fig 5. Knowledge management Life cycle process is shown in fig 6. This process is centered primarily on business strategy and Knowledge Management objectives of the organization. This process is to be reviewed periodically and improvised wherever needed. All identified business information is captured, codified and tested before this knowledge is shared and transferred. The knowledge is made available to all needed users for its effective use in their mission. Predictive models pertaining to the business requirements can be developed to 'alert' users through automated process by 'flagging' or e-mail and ensures that all prospective users know the new knowledge and used without being idle in repositories. Knowledge Management system is to be attuned with the organizational culture and facilitate flow of knowledge, and encourage people to share insights, experiences and know-how, while ensuring that the right information is available with the right person at right time.

Community of Practice

In organization, knowledge is created by people but enabled by systems and technology. Effective capturing of the valuable tacit knowledge of an individual and sharing within the organization will add special value to the growth and competitive advantage. Teamwork could be yet another knowledge capture process. The team could have experienced members, experts and beginners. Individual knowledge is shared with the other team members during the discussions or correspondences, when they work on a subject or find solution for a problem or carrying out a task or a job or jointly working on a project. Knowledge is still available with the individual but not with the team. Individual behavioral traits, motivational

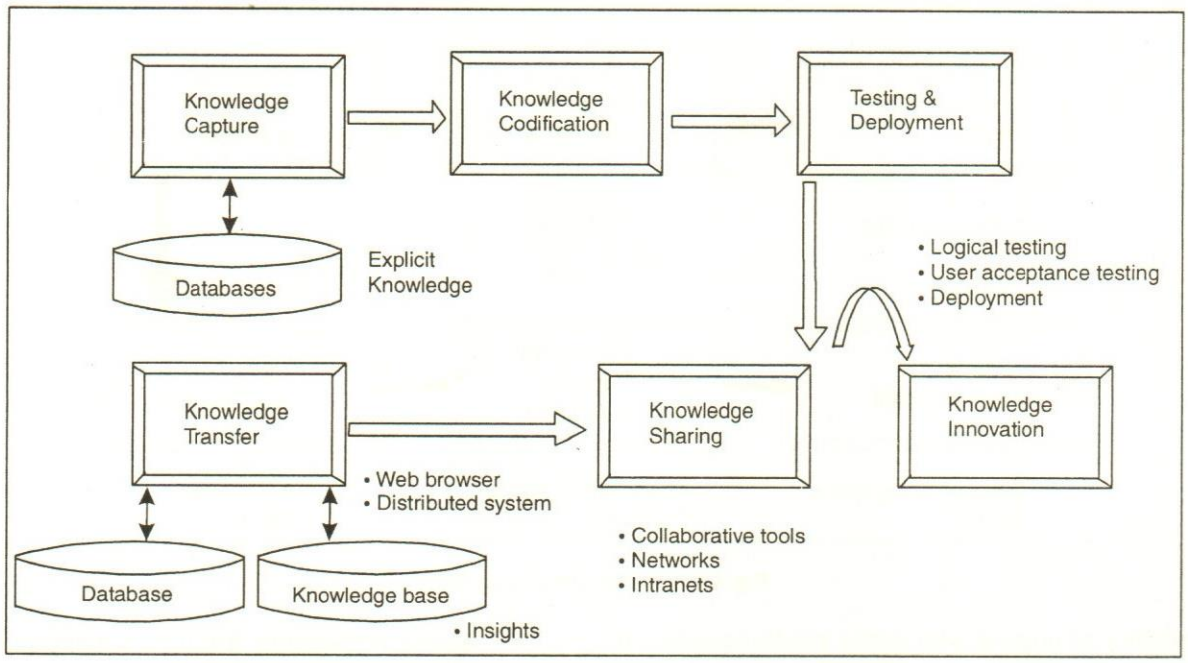


Fig. 6. Knowledge Management Life cycle process

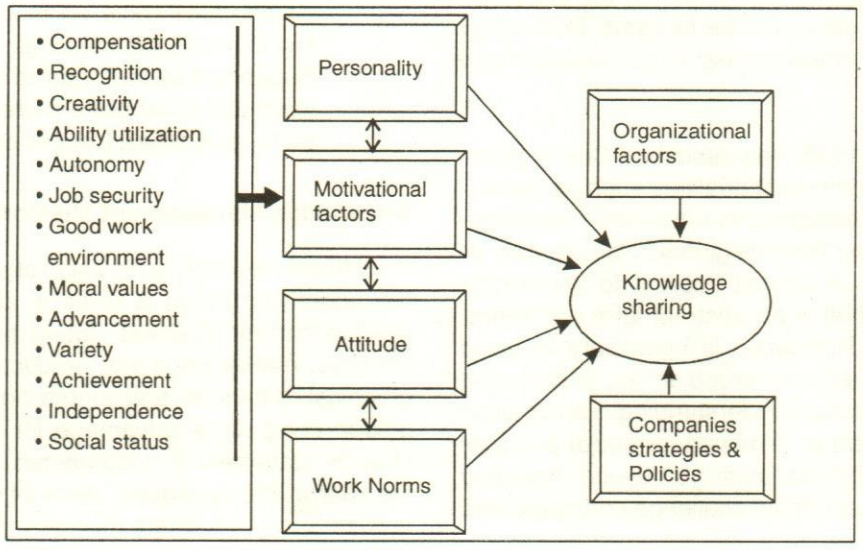


Fig. 7. Individual traits & knowledge sharing

factors - recognition and rewards, organizational culture and company strategies and polices have an impact on this knowledge sharing process as shown in Fig. 7.

When the team collaborates with the common purpose over an extended period, the ideas, alternative approaches, expertise and solution to a subject do emerge. This knowledge is captured and shared with other teams within the department(s) or functions or strategic business unit or corporate. Following such practice within a community enables social learning, nurturing new knowledge, stimulating innovation or sharing the existing tacit knowledge within the organization. A typical illustration is shown in Fig. 8.

From the above process, the individual learning startlingly increases through collaborative learning and also the organization benefits by the business solution. Moreover, the organizational learning increases and the knowledge is accumulated in corporate memory. After review and approvals, the organization can share this new knowledge with other allied communities within the

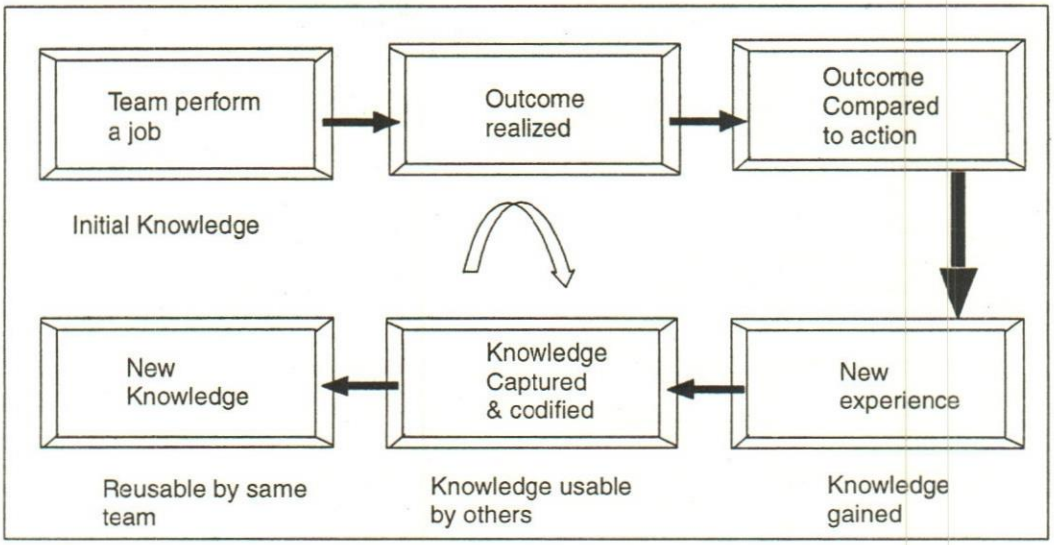


Fig. 8. Knowledge creation via Team

same industry or anyone who seeks similar knowledge could use readily without much effort. This social learning shared practice within community is known as Community of Practice (CoP). Generally, CoP is formed within a single discipline so that the effort can be focused. Technology that exists today ameliorates multi-disciplinary participation.

Etienne Wenger (1998) has described CoP in terms of interlaying four fundamental dualities such as 'participation vs reification', 'designed vs emergent', 'identification vs negotiability' and 'local vs global'. 'Participation vs Reification' duality is of utmost interest to knowledge management. Reification is an abstract form and represented in document. Reification is necessary to avoid teamwork turning into informal group activity in the name of co-ordination and mutual understanding. Participation is an active involvement in teamwork or social process. Involvement of an individual must go beyond repeating the reified description and must challenge and readdress its meaning.

Community Practices – Features

- Promotes innovation through problem-solving, learning, knowledge creation, self-manage & self-govern.
- Combats isolation. Support one another to enhance learning and performance.
- Enable productive inquiry for creation of job-critical knowledge and exchange. Members create knowledge base. Enhance speed of response to customer.
- Share knowledge through collaborating and learning.
- Use a variety of synchronous and asynchronous collaborative tools via multiple channels including face-to-face meetings and on-line platform Supported by the organization as a valid way to learn and collaborate. Increases capabilities and meta-capabilities. Creates competitive advantage.

Knowledge Management Mission

Mission is a long-term vision of an organization where the underlying thrust is given in abstract form with regard to current business, future business it intends to possess, market segment, products and services, geographical dispersion, and contribution it can make to have unique competitive advantage for survival and growth. Mission statement is documented and used for guiding the rest of the operation. Aims of a large organization may be broad as it has diverse products and services, and strategic business units. Little vagueness does exist in mission statement for some products and services, as it is difficult to foresee more realistic goals.

Similarly, a Knowledge Management Mission statement to be made succinct after reviewing the existing products and services, business process within a strategic business unit or among the units, business forecast, geographical dispersion, emergent technology solution both hardware and software that exists today, Knowledge Management Lifecycle requirement, knowledge networks and culture the critical most for the change process. Knowledge driven organization to address on accumula-

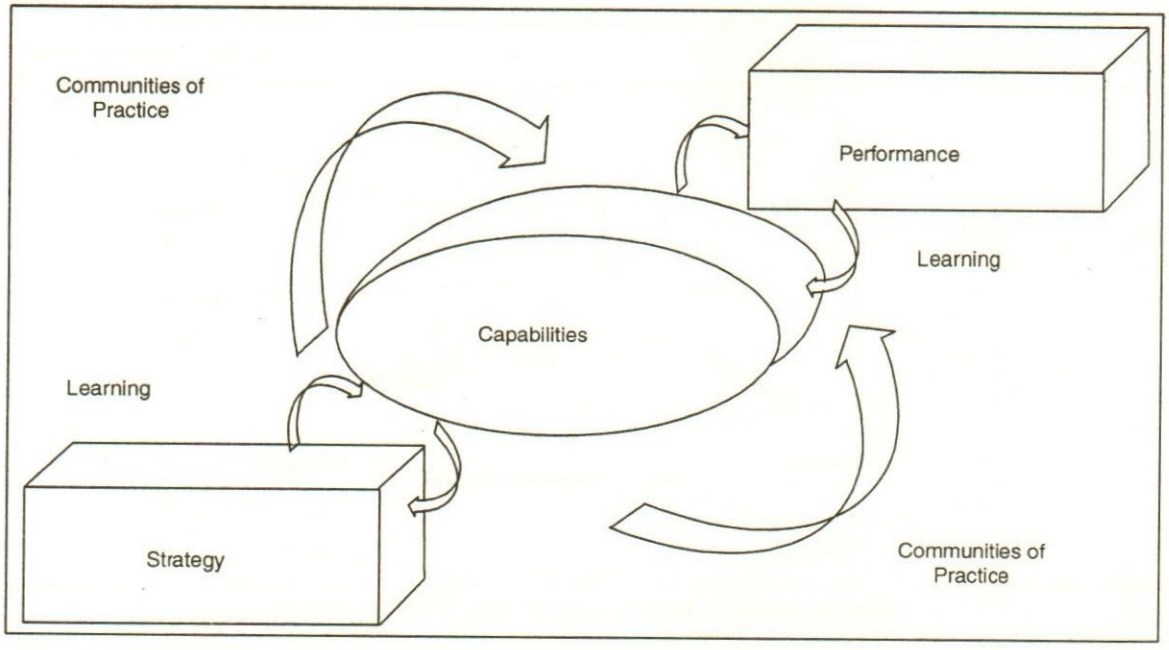


Fig. 9. Organization capability building

tion of what knowledge exists, what knowledge is intended to augment, Knowledge audit, Knowledge gap, Knowledge mapping, Knowledge sharing, Knowledge transfer, and how to accrue further knowledge while executing the business process using existing or automated expert system. Mission represents all areas of operation and leverage knowledge innovation, operational excellence and competitive advantage in the organization. For example, the following thrust areas can be interlaced in the Knowledge Management Mission:

- "To create a knowledge driven integrated virtual environment within the organisation and ameliorate innovation through collaboration independent of geographical dispersion"
- Enhance Process velocity and respond quickly to the customer
  - ✓ "Simplification" - Simplify the systems, methods and process after review by challenging the existing practices.
  - ✓ "Improvisation" - Improvise the existing systems, methods and process.
  - ✓ "Expert System" - Substitute the expert system for the existing critical process.
  - ✓ "Synergy"- combination of any of the above or combination of Research and development, and Production capability etc.

Knowledge strategy formation and Measurement system

Knowledge is the critical strategic resource to the organization. An intellectual resource available in the organization is to be identified to leverage knowledge and build capabilities required for business strategy as shown in Fig. 9. Organization is using primarily intellectual resources and capabilities to develop various product and services for different markets. Intellectual resources and capabilities are knowledge driven and continue to exist in the organization, whereas the products and services do have lifecycle in the market. Traditionally, the organization's business strategy used to address product and services sales, time to market, positioning, distribution networks, pricing, capacity utilization and augmentation, customer retention, revenue growth etc. Knowledge-based strategies position the organization in terms of their unique, valuable and inimitable resources and capabilities. Knowledge-based strategy encompasses product innovation, knowledge creation, intellectual capital, process, innovation, knowledge sharing, collective learning culture, business innovation, customer, vendor and external knowledge integration. To remain competitive and maybe even to survive, organizations are presently considering to align knowledge-based strategies to business strategy. Thus, knowledge is to be radically exploited, explored and managed to build capabilities within the organization to convert into organizations of knowledgeable specialists to attain competitive advantage.

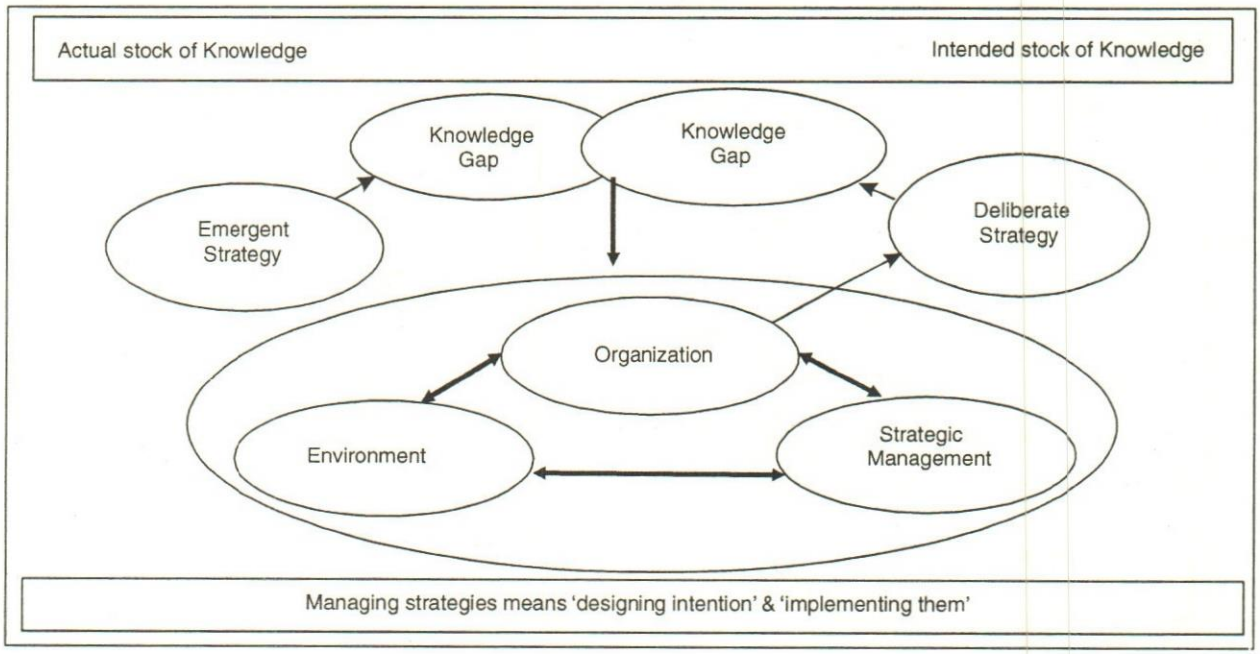


Fig. 10. Knowledge Strategy

Organization to perform SWOT analysis on their intellectual resources and capabilities with respect to Strength, Weakness, Opportunities and Threats of the competitive environment to develop Knowledge-based strategy. Strengths to be conserved, secured and fortified while weakness to be analyzed with the probable cause and effect, and countervailed. Develop measures to alleviate or challenge threats with more innovation. Foresee business prospects in different product and services, and markets and take advantage to capture for the organizational growth. Knowledge-based strategy is formulated with development of 'emergent strategy' – what to do? How to do it?, and 'deliberate strategy' – what will be, how to do, to identify the knowledge gap as shown in fig.10. Based on intellectual resource and capability map, the extent of knowledge availability is in alignment with the business requirement of an organization. Thereby, organization can quickly understand what it can do and what it must do to bridge the knowledge gap.

Emergent strategy is a short-term strategy that seeks to identify the knowledge gap and create knowledge through innovation for improvement of the products and services, process and business strategy. Emergent strategy is required for the 'survival' for operational excellence and for sustaining competitive advantage. Deliberate strategy is a long-term strategy required to foster knowledge to address emerging requirements of the markets such as periodic introduction of a new product and service with shorter development cycle and added value to the stakeholder. Deliberate strategy is required for 'advancement' of an organization by building knowledge in anticipation of up-coming business and retaining competitive advantage.

When an organization implements a business strategy aligned with knowledge strategy and aims to achieve competitive advantage, the competing organization might not have simultaneously implemented similar strategy. One organization's success will inspire competitors and some may respond by evolving superior features in their product, service and business strategy. Knowledge–based strategic organization can consistently outperform and retain competitive advantage and attain a 'unique position' in the market, as the competitors may take some time to compete. But this phenomenon may not be permanent over a period of time. Organization has to at least 'survive' when the competition surpasses in the market. But, it is certain that the knowledge-based strategic organizations that have begun their 'Knowledge Management' with the long-term approach will rapidly rise to meet market requirements and achieve a competitive advantage. Both formulation of strategy and timing of its introduction plays a vital role in the business.

From the above scenario, it is clear that organizations have to develop knowledge–based strategy in alignment with business strategy and continue to achieve competitive advantage either for 'survival-sustenance' or 'advancement-growth' or the balance between the two. An overview of advancement and survival activities is summarized in Table 1.

'Advancement' activities	'Survival' activities
• Developing distinctions & norms	• Product market positioning
• Scaling Advancement activities knowledge	• Planning and Deciding • Production
• Process Automation	• Controlling
• Ensuring knowledge connectivity	• Resource devpt & deployment • Organizing

These strategies further dovetailed into Knowledge Management objectives and their further goals. Traditionally, a balanced scorecard is used for measurement of the organization's performance with respect to their strategic plan. Balanced scorecard addresses financial, customer, internal process and innovation perspectives as shown in Fig. 11.

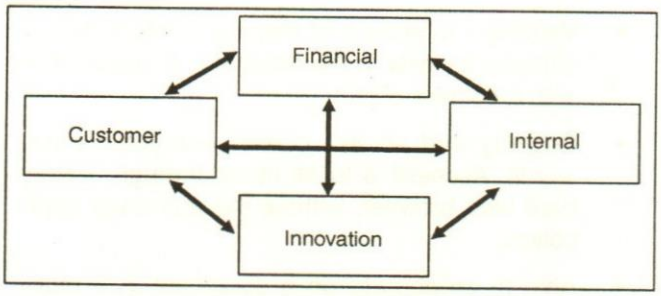


Fig. 11. Balanced scorecard

Scandia Navigator is also used to measure the organization's performance with respect to strategic plan in terms of financial, intellectual capital, customer, human values, process focus, renewal and development focus, organization in today's context and how it will be tomorrow as shown in Fig. 12. Both of these methods are enabling the organization to understand its performance in terms of tangible and intangible values.

Knowledge Management Objectives

Objectives are broad and timeless statements and represent both quantitative and qualitative terms. A goal is a specific and time-based measurement of organizational objectives. Both objectives and goals indicate the specific kinds of performance and results, which an organization seeks to produce.

Knowledge Management shall include the following broad objectives:

- Create and promote knowledge availability within an organization for products and services.
- Understand the external environment and tap knowledge from other or allied organizations
- Achieve shorter new product development cycle and operational excellence.
- Facilitate and regulate organizational innovation and learning.
- Share and leverage expert knowledge across organization.
- Build knowledge networks and Community of Practice for collective learning through collaboration by increasing the connectivity between employees.
- Facilitate required knowledge access rapidly and best practices. Promote knowledge transfer through training, rewards and motivational factors.
- Identification, capturing, sharing, preservation and management of an intellectual capital.
- Review and improvement of the Knowledge Management system.

Knowledge Creation

Business explicit documents available in different media are to be listed for every function for every product and services and then to be classified according to their current, strategic and future importance or for preservation and management. Methods and efforts required to capture all these documents in soft media so that tracking, managing, sharing, access control etc., can be possible with software tools the exist today. During execution of various activities in the business mission, knowledge management system facilitates automatic or online capture of explicit knowledge. Nature of business documents can be product-specific documents, process specific documents, project-specific documents, preservation of software, legacy documents, training documents, patents, reports, service-related documents, etc,.

Goals

- Availability of information to the right person at right time.
- Creation of knowledge assets and document management. Many users to work on a document concurrently on either the same section or different sections, if need arises.
- Electronic Content Management to enrich the content's profile to some extent automatically

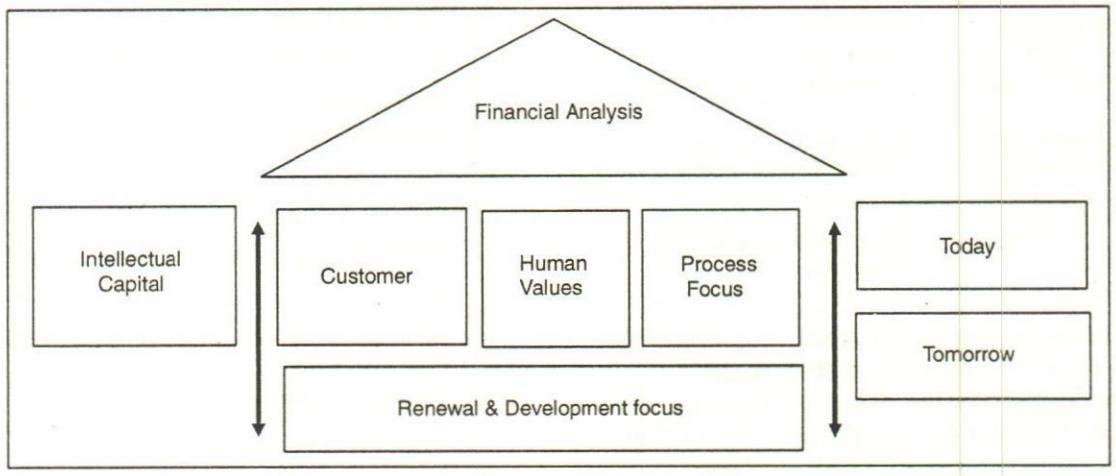


Fig. 12. Scandia

using filtering, routing and pathways, organizational specific knowledge taxonomies and semantic networks. Knowledge repository structure to facilitate capture, manage, store, preserve and deliver content and documents to the business process.

- Integration of Workflow management: production workflow – predefined sequences to guide and control process, and ad-hoc workflow - user can determine sequence.
- Configuration management and change management.
- Integration of Web content management – visualization, delivery and administration of information, secure access to public and non-public information, facility to edit and publish etc,.
- Improve the repetitive and paper-intensive business process to paperless process.
- Facility for notification, tracking and alert mechanisms and ability for electronic approval of documents & advancing them to the next stage.
- Reduced search time. Improved traceability with version tracking to record the history of documents and editing controls built in.
- Build search engine capability.
- View, mark-up and storing of markups facility during the document's lifecycle.
- Link business documents to related parts and components as well as to various product configurations and their bill of materials. Facility to link single or multiple documents to a single document object when needed.
- Automatic archival from business process.
- Vaulting - to store and manage content data in different formats in the database, in association with a content object.
- Security and access control encrypted passwords. Accessible to all users through a standard web browser, without the authoring application.
- Able to collaborate on a document in a multi-user mode during reviews and meeting.
- Transformation to be controlled and trackable by use of PDF, converters and viewers, compression, syndication, personalization, XML etc,.
- Publishing.
- Long-term preservation strategies.

Knowledge conversion

Merely storing structured knowledge constitutes only some part of knowledge management. Every process used to create, communicate and apply tacit knowledge will result in new knowledge e.g.: a worker applies knowledge from a similar problem/resolution from a database and the final solution may differ in some way. This successful resolution to be documented and saved and will now expand the organizations knowledge base. To convert tacit knowledge to explicit knowledge, the following goals are required to be achieved to address this objective.

- Prevention of Knowledge Loss due to employee turnover on transfer, retirement, resignation, mindset of individual etc.

- Prevention of duplicate activity. Everyone need not re-invent when somebody within the organization had already done that activity.
- Adaptability and Flexibility – allows employees development to better grasping power of their work and may require less direct supervision and fewer interventions.
- Capturing of Technical Problems and Solutions can be easily referred to during problem analysis thereby reducing time.
- Promote collaborative learning through Communities of Practice.
- Motivate individual with reward system for knowledge sharing and capture in document for further transfer.

For conversion of tacit knowledge to explicit knowledge, the process to be developed by identification of mission critical functions, formulation of systems, format structure and key factors that are to be captured, content, procedures, and measures required to promote involvement of individuals and associated functions or departments.

Knowledge conversion process is shown in Fig 13. Nonaka and Takeuchi (1995) developed four-stage spiral model for knowledge conversion within business process and the summary is given below.

Externalization

Tacit knowledge of the expert or key personnel within the organization can be made explicit by documenting the knowledge one posses or procedure or steps followed up in completing a given task and the experience gained. This codified manual can be shared and this knowledge incorporated in the development of other products and services. This process of converting tacit knowledge to explicit knowledge is known as externalization.

Internalization

The reverse process of conversion from explicit knowledge to tacit knowledge is known as internalization. The codified context specific explicit knowledge to be reviewed and absorbed by the employees so that the formal rules and procedures can be adapted in the same way when such similar requirement arises during the development of new products and services.

Socialization

This is a conversion from tacit knowledge to tacit knowledge through sharing of experiences, models, imitations and practices. This type of knowledge transfer takes place during coaching, apprenticeship, presentation, seminars, meetings, conferences, training, workshop and any other informal interactions within and outside the organization.

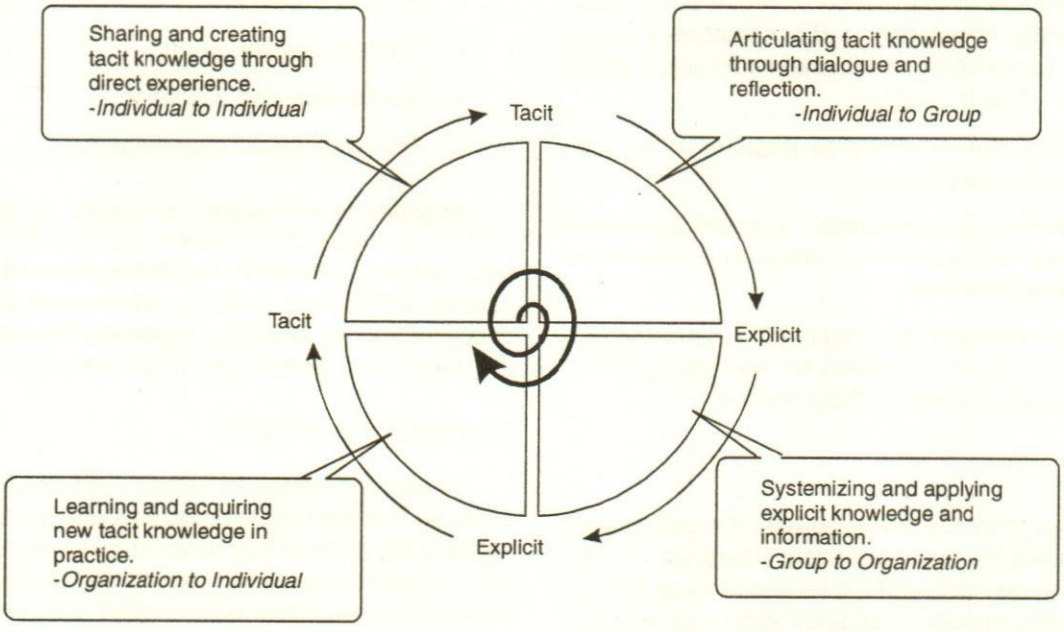


Fig. 13. Knowledge creation spiral

Combination

The accumulated knowledge is disseminated by sharing with one another or within the function(s) or group(s) or community or communities. It is a conversion of explicit knowledge to explicit knowledge This transfer process is a primary way to leverage knowledge.

Knowledge use and reuse

Knowledge-based system known as 'Expert system' is developed with business specific domain knowledge from one or more experts. The expert system can have features of 'fully automatic' for closely repetitive process or 'semi-automatic' for varying repetitive process and 'manual' option for first time creation. Expert system is essential for organization that has high-level of know-how experience and expertise and cannot be easily transferred to other members. Thorough review of business process with respect to the following key factors is essential before deciding on substitution of 'Expert system' to the existing process.

- Criticality of the process (e.g engineering, production, marketing etc).
- System/methods currently followed for development of new product or engineering of equipments or custom-built equipment for a given plant or services.
- Identify the current knowledge level and the missing knowledge.
- Percentage of application or reuse of the existing design knowledge (part or component, equipment information), additional information added to complete the activity.
- Cumbersome or expertise required for an individual process is high.
- Productivity requirements - Present cycle time and required to address market requirements and capacity utilization.
- Rework or repair resulting out of a particular process due to inconsistency or overlapping in certain steps followed in that process.

Goals

- Development of knowledge-based expert system with Graphic User Interface, inference engine, knowledge base and explanation facility. Design templates specific to an application to be mapped based on interactions and expertise from the discipline experts, and will be running in the back-end. Many experts intelligence is combined and this reusable scarce knowledge which is invisible to the user and is secured.
- Enhance productivity in all critical mission processes.
- Prevention of duplicate activity by using the existing information.
- Reuse existing design information and collaborate concurrently during the execution of a task so that more than one individual can be involved if needed to accelerate the process.
- To achieve accuracy and consistency on desired output from every process.
- Virtual prototype e.g: mechanical assembly, routing & simulation.
- Routing for approval and mark-up, records of comments.
- Automatic soft document back-up, archival & integrated management.
- Effective collaboration and facilitate concurrent engg etc.

Expert system development life cycle as given by DiStasio, Droitsch, and Medsker (1999) is as follows:

- Problem identification and description
- Domain understanding & knowledge acquisition
- Structure design and knowledge organization
- System development
- Verification and validation
- Operations and maintenance

Knowledge ontologies are used to structure the knowledge base of an expert system. To build knowledge ontology, Gomez-Perez (1998) followed these steps: acquire knowledge, build a requirement specification, conceptualize the ontology, implement the ontology, evaluate during each phase, and document after each phase.

Knowledge dissemination

To use knowledge to deliver products and services, make knowledge to solve problems and the like. Dissemination is the primary way to leverage knowledge throughout the organization. Both explicit and tacit knowledge is shared in a real-time environment that will assist the employee to perform unique functions effectively. By this process, individual can access divers resources and new

expertise. Such cross-fertilization of knowledge creates value for an organization.

Knowledge transfer is done by working together, learning by doing, apprenticing, face-to-face discussion, or embedding knowledge through procedures and document exchange. The collective learning of an organization is gleaned from the learning of its members as well its stakeholders and customers. Collaborative technologies are used to aid in effective knowledge flow. Knowledge sharing recognizes the nature of knowledge and classifies them as 'quick knowledge', 'broad-based knowledge', 'interest knowledge' and 'complex knowledge' and accordingly shared as shown in Fig. 14. The term share is an exchange of knowledge between individuals, between or within teams or between individuals and knowledge bases, repositories, and so forth.

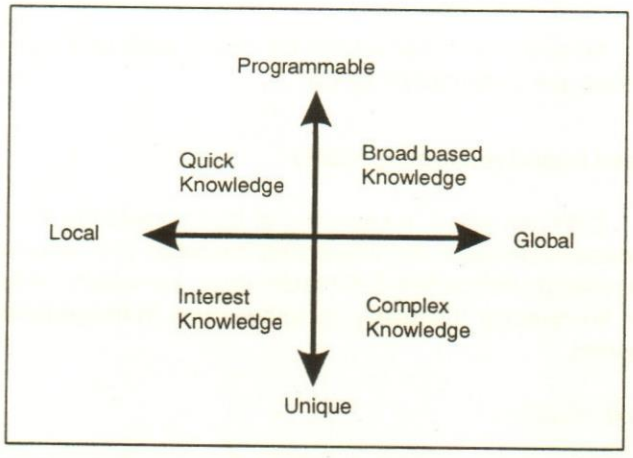


Fig.14. Knowledge sharing

Goals

- To promote knowledge sharing, collaboration and networking of knowledge throughout the enterprise on need to know basis.
- Quality and speed of transfer.
- Concurrent use of knowledge by many.

Knowledge security

Captured knowledge is treated as a competitive weapon. The security levels for knowledge sharing need to be deliberated in all business process levels. It is also felt that it is potentially dangerous to share the documentation, as the credibility of the users cannot be established concretely. However, an attempt has to be made to underline the need of security of information while deciding the sharing of information among the working groups. Knowledge Management system must be secured from any unauthorized access either internal or external. In addition, it must allow secure access for any authorized user, no matter where they are. The system should support security features like electronic signatures, firewalls, encryptions, HTTPS etc.

Goals

- Build security features like electronic signatures, firewalls, encryptions, HTTPS etc,.
- Protecting the data from external threats.
- Protection against network attack, malicious code, virus, unauthorized application execution, Security at desktop level, User management etc.,
- Implementation of access control at different levels such as user level, functional role level, etc., to control access to the Knowledge Management system.
- Create and maintain an access control list for each object created within the system.
- Build an audit mechanism to keep track of access, check-in/check-out, status change etc

Customization of Policy based integrated enterprise level security software to be introduced for protection against network attack or malicious code or virus or unauthorized downloadable application execution etc. is to be prevented through access control, security and firewall systems. Overview of security levels are given below:

User Management

- Security implementation at user, group and functional role level to control the access to the data stored in the volume.
- Shall support single sign-on to network resources.
- Ensure secure credential and focal point for user management.

  Provide heterogeneous directory synchronization.
- Facility for password management.

Desktop management

- Control security settings with Group Policy.
- Control desktop configurations.
- Enable user's data & settings to follow them.

Application management

- Standards-based, interoperable architecture.
- Reliable, fault tolerant design.
- Service publication eliminates desktop configuration.
- Easily replicate user profiles and preferences.

Knowledge Discovery

Knowledge discovery is used for knowledge creation in Knowledge Management system such as discovery of business intelligence, insights, new relationship, trends, patterns etc., from various functions or processes. Various information from different or associated processes are to be captured, classified, compared, synthesized and derive the insights, trends, patterns etc using software tools that exist today or customized tool is to suit the required business process. From this knowledge discovery process, Knowledge Management system is to enable creation of management information report automatically and alert the user by flag or e-mail in addition to provision of business process interlocks between processes. Knowledge discovery process aids organization to solve inter-disciplinary problems, improve business process efficiency, productive and proactive.

Knowledge discovery system to provide unified access to information assets, regardless of format, repository or media type and increases user productivity by reducing the time and cost of finding information in the sea of data. Filtering new information in real-time, convert data to knowledge discovery, personalize and organize the retrieved information in folders, or share expertise with associates shall stimulate knowledge discovery across the enterprise. It shall utilize a variety of indexing, concept and entity extraction, and content filtering methods regardless of content type – unstructured, semi-structured, and structured.

Goals

- Create high level abstract business insights, trends, patterns etc and make it available for effective decision-making.
- Knowledge discovery system shall be scalable and have consistent taxonomies for categorization and pragmatic classifications for information access.
- Create semantic Indexing based on domain-specific application indexes
- Develop strategies for Data Management and applications.
  - ✓ Data sources – Flat files, Relational databases, Data warehouses, Business unit wise databases, Time series databases, geographical databases, etc,.
  - ✓ Taxonomy of Data – business transactions, Technical design methodology and calculations, Process related, Testing related, personnel related, Text and documents, repositories etc,.
  - ✓ Data preparation – Evaluating data quality, Handling missing data, Processing outliers, Normalising data, Quantifying data etc,.
- Model building – Association rules, Classification trees, Neural networks.

An overview of knowledge discovery tools and techniques are summarized below:

Case based reasoning (CBR)

CBR can assist in capturing of tacit knowledge from process-centered activities and manage procedural knowledge. Interactive CBR techniques are widely used for knowledge discovery in knowledge management system.

Text mining

Text mining involves extracting patterns, behaviours and general knowledge from a large collection of textual information, which are found in knowledge repositories. Text knowledge mining process aids to develop Self-Organizing Maps (SOMs), clusters and productive models (Rules). SOM brings together related concepts and shows their intensity or frequency within the data/text based as well as their proximity to other concepts. Fuzzy clusters provide a spatial analysis of documents and semantic concepts in the form of related aggregations.

Neural networks

Neural networks are used to infer patterns from data, knowledge and image e.g.: GUESS (Generically used experts scheduling system). Push Technology, Quantitative analysis, Data mining tools etc are also used for knowledge recovery.

Data mining

Data mining is a process that uses sophisticated

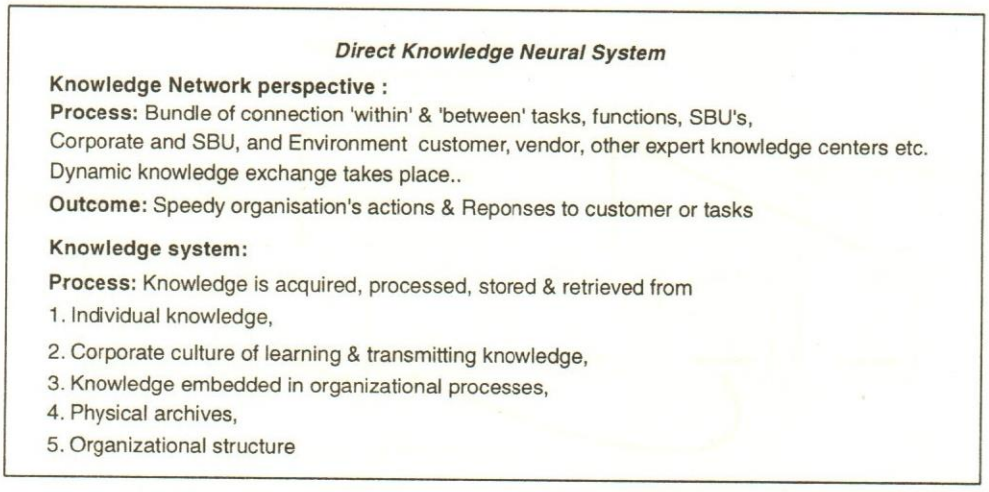


Fig. 15. Direct Knowledge Neural

statistical analysis and modeling techniques to uncover patterns, correlation and relationships that exist within the data but are not recognizable using conventional data analysis techniques. Data mining provides response to extracted patterns, selection of the right action, learning from past actions, and turning action into business values.

OLAP (On-Line Analytical Processing)

The need for non-static reporting system has led to the development of on line Analytical Processing. It is possible to drill down into the ultimate detail of a parameter and zoom up for a general view. OLAP have the ability to answer what-if and why questions along with Multidimensional views of data, Calculation intensive capabilities, and Time intelligence.

Knowledge Network

Knowledge is available in individual, tools, documents, databases, knowledge bases, group, function, particular SBU and corporate. Organization to recognize the new knowledge that gets created as a by-product while individual's carrying out an activity or task or product or project or service. This knowledge is effectively useful only when it is dynamically transferred and shared as and when the knowledge is created. Knowledge Network enables knowledge transfer. Knowledge Network connects individual to organization and vice versa. Knowledge network along with other knowledge process can be used to capitalize this new knowledge. In Knowledge Management system, knowledge is captured, transferred, shared, synthesized and transacted in real-time with all authorized individual. Utilization by any part of the function or department or organization independent of location leads to organizational competency.

Technology that is available is potentially adequate to connect all knowledge workers in real-time. Speed, accuracy, volume, distance, security and maintenance are critical factors to build a network. Intranet, Internet, Extranet, Local area network, Wide Area Network, dial-up links, and Legacy networks are widely used depending upon the size and requirement of the organization. Increased connection between employees will be productive knowledge transfer and leverage the expertise of an individual across the organization. Knowledge Networking enhances the individual and organizational learning which will aid business requirements. Knowledge network constitutes of both 'Direct knowledge neural network' and 'Indirect knowledge neural network' as shown in Figs. 15 & 16. SBU's can be geographically distributed in different location or some SBU's can be distributed in one country or across many countries, and all can be connected in Knowledge network. This feature facilitates collaboration and execution of activities concurrently. Neural system is dynamic. Interrelation continuously transforms and activates various functions depending upon the stimuli from environment and/or within organization.

Knowledge Audit and Mapping business process

Knowledge Audit

Knowledge audit is a systematic appraisal of the organization's intellectual resources and capabilities with respect to identification of existing knowledge, adequacy, gaps, sources, sinks, flows and recommend measures to augment the required knowledge. Audit reveals how

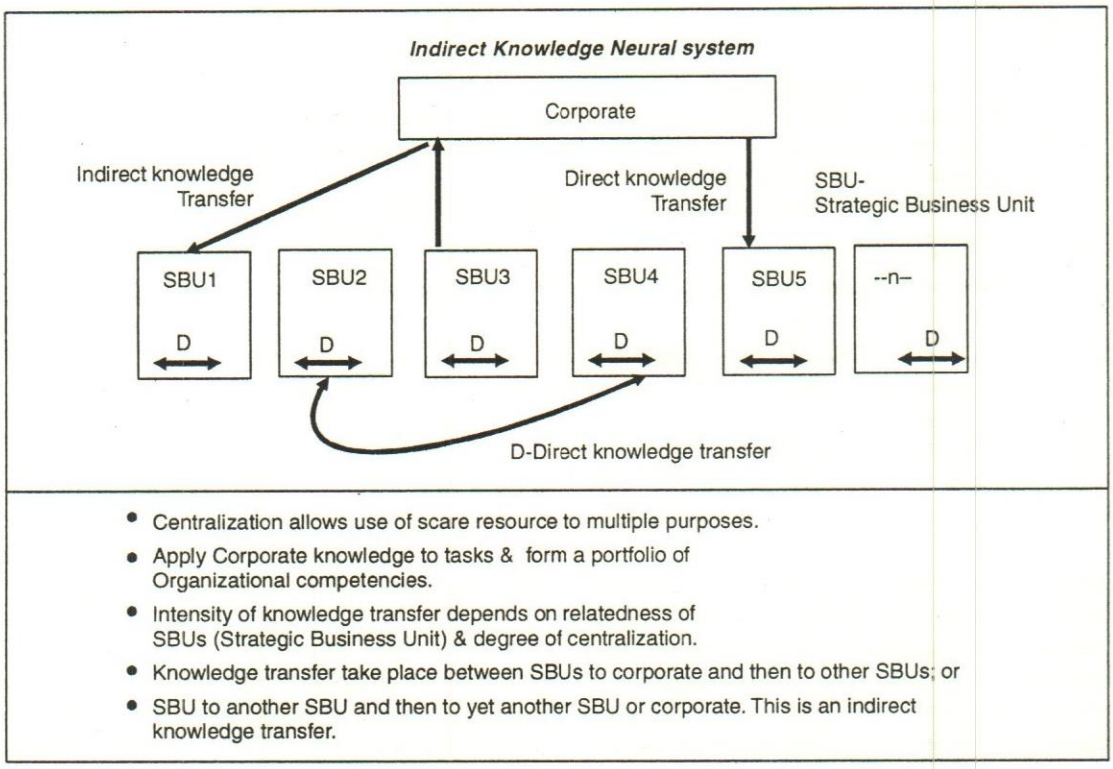


Fig 16. Indirect Knowledge Neural Network

the knowledge that exists is not exploited, knowledge required but not explored, and the extent of utilization of organizational knowledge flows around. Knowledge audit provides evidence-based qualitative assessment to individual, team, function, SBU and corporate. Identification of knowledge sources within the organization and the best external sources leads to quicker acquisition of knowledge required for the business. Knowledge audit enhances the stakeholder value by this process.

Various knowledge audit methods are used. Snowden (1999) believes that the best representation for knowledge map is stories that contain context, value, and the message. Dataware (1998) believes that productive analysis require to answer questions like: What knowledge we have, what knowledge is missing, who needs this knowledge, and how it will be used? Wiig's (1993) knowledge analysis is summarized below:

- *Questionnaire-based knowledge surveys* are used to get an overview of various operations of an organization.
- *Middle management target group sessions* are used to understand their need for management support.
- *Task environment analysis* is used to understand the existing knowledge and its extent of application.
- *Verbal protocol analysis* is used to identify knowledge elements.
- *Basic knowledge analysis* is used to identify aggregated knowledge.
- *Knowledge mapping* is used to develop concept maps as hierarchies or nets.
- *Critical knowledge function analysis* is used to identify knowledge-sensitive areas.
- *Knowledge use and requirement analysis* is used to identify how the knowledge is used for business purposes and how situations can be improved.
- *Knowledge scripting and profiling* is used to understand the details of knowledge intensive work and the role knowledge plays in delivering the quality products.
- *Knowledge flow analysis* is used to gain an overview of knowledge exchanges, losses, inputs of the business processes.

Knowledge Mapping

Knowledge map is a visual contextual representation in graphs used to codify the knowledge. Formal, informal, explicit, tacit, internal and external knowledge can be represented in knowledge map to identify the business issue. Knowledge map is used to generate job specific knowledge requirements, to communicate complex process, develop knowledge structure that represents concepts and their relationship, building employee knowledge competency and understanding. Various methods are used to create knowledge map and few are illustrated in Figs.17 &18. Marketing function has very less interaction with engineering and more interaction with finance as depicted in bidirectional arrow line (P-person), whereas the interactions to be otherwise as marketing need to have more interaction with engineering than with finance.

Critical factors	Available	Not available	Who has
Design knowledge	Yes		K
Production knowledge	Yes		L
Strategic planning		No	

If the subject 1, 2 & 4 are associated, then the expert R is very useful. Suppose 1, 2, 3 & 4 are totally different, then the earlier assumption will not hold. Fig.17 illustrates the area of concern as Strategic planning and depicts who has knowledge in each function. Knowledge mapping is very useful for effective decision-making. If the subject 1, 2 & 4 are associated, then the expert R is very useful. Suppose 1, 2, 3 & 4 are totally different, then the earlier assumption will not hold. Fig.17 illustrates the area of concern as strategic planning and depicts who has knowledge in each function. Knowledge mapping is very useful for effective decision-making.

Knowledge Management and Organizational culture

Organizational culture is to be conducive for knowledge transfer and knowledge sharing. Knowledge transfer provides knowledge to someone else whereas knowledge sharing is an exchange of knowledge between individuals or teams and knowledge bases. Individuals will resist sharing for competitive and self growth. Almost any organization and all global ones have multiple cultures. Organizations must make employees believe that their services are required for the long-term and not as replaceable commodity, which will enable them to share knowledge between peers. Organizations must provide tools for capturing, storing, sharing; training and education; time-to absorb, use and share new knowledge; and empowerment to use knowledge.

Making knowledge available and sharing it with employees or sharing between individuals connotes certain level of trust. For a positive knowledge sharing, co-operation, collaboration and collective learning, building altruistic culture by development of on-line and off-line systems of knowledge dissemination promotion and measurement system with motivational drivers like reward, recognition, compensation etc is essential. Positive organizational cultural values are Leadership, understanding the mission, internalizing the management practices, and trusting one another. Organizational culture is to be conducive for knowledge transfer and knowledge sharing. Knowledge transfer provides knowledge to someone else whereas knowledge sharing is an exchange of knowledge between individuals or teams and knowledge bases. Individuals will resist sharing for competitive and self growth. Almost any organization and all global ones have multiple cultures. Organization also must make employees believe that their services are required for long-term and not as replaceable commodity, which will enable them to share knowledge between peers. Organization must provide tools-for capturing, storing, sharing; training and education; time-to absorb, use and share new knowledge; and empowerment to use knowledge. Making knowledge available and sharing with employees or sharing between individuals connotes certain level of trust. For a positive knowledge sharing, co-operation, collaboration and collective learning, building altruistic culture by development of on-line and off-line systems of knowledge dissemination promotion and measurement system with motivational drivers like reward, recognition, compensation etc is essential. Positive organizational cultural values are leadership, understanding the mission, internalizing the management practices, and trusting one another.

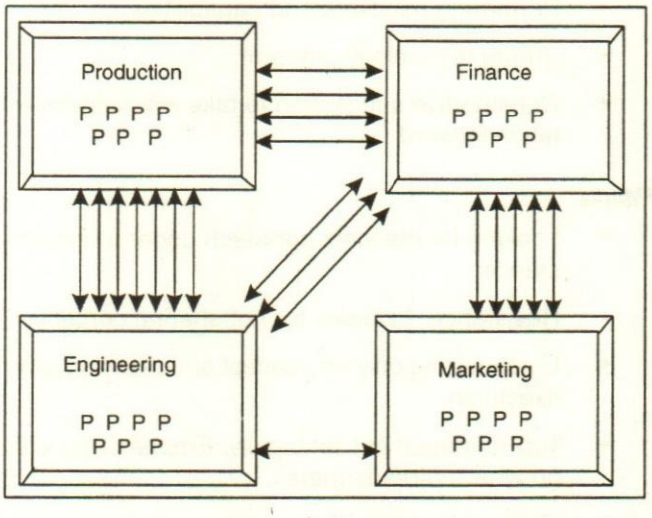
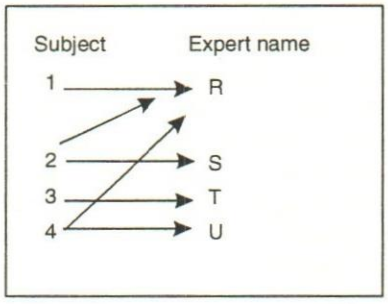


Fig. 17. Knowledge mapping



Critical factors	Available	Not available	Who has
Design knowledge	Yes		K
Production knowledge	Yes		L
Strategic planning		No	

Fig. 18. Knowledge map

Top management must have conviction, commitment and support in word and deed for implementation of Knowledge Management as this endeavour calls for change management in the area of process, values and business strategy. Otherwise, knowledge management implementation efforts will be strained due to the diversity of interests. Organizational cultural change takes time to attune to the knowledge based strategy driven culture and particularly the outcome depends on leadership. Organization requires having patience and persistence while certain employees resists for change. Knowledge exchange process will also certainly enable positive change in the organizational culture.

Precursors to success

- Top management conviction, commitment and leadership endorsement
- Shared sense of purpose and ownership
- Self-initiated view of learning and readiness to learn from each other
- Climate of trust and involvement
- Partnering mindsets and capabilities
- Strong technology platform
- Constructive suggestion to take KM implementation forward

Pitfalls

- Looking for the ideal approach under all circumstance
- Resistance. Excuses for not sharing content
- Emphasizing only on concept and planning, over execution
- Top management ambiguity. Emphasizing only on what's already there
- Underestimating the technology that exists today
- Failure to identify organization's position with respect to global competitors.
- Inadequate focus and value for development of core competency for New Product development, Facility and overall process system improvement
- Senior internal executives not freed-up to drive the KM programme due to exigency of work

Overview of software tools and solutions for KM

Diverse products and services are provided by organization(s) to different market segments. Technology varies for different product, process and services do. Also the requirements and KM strategy of different organizations will also vary. Knowledge audit and scoping needs includes requirement gathering, understanding the existing process and IT systems, review of best practices, review of software products, vendor evaluation, visits to the organization where KM is already implemented, taking support from KM consultants, proof of concepts demo etc will have to be done before selecting the software and hardware products. There is no single software addresses all requirements of all organizations and some combination of software tools are required for KM. e.g. for engineering enterprise, integration of many discipline and software, and exploitation of software features for different business process are critical while selecting the software for KM.

Some vendors have homogeneous solutions for many requirements of KM. Few vendors have built-in knowledgeware of their software products which will provide bidirectional, synchronous and asynchronous features for applications. Many of the vendors use all KM jargons but it is felt that the degree of their product features is varying widely. Few vendors are having software that will meet only few KM requirements and they get different software from different vendors and integrate them to meet the total KM requirements. In this scenario, the solution is offered from heterogeneous sources. Many

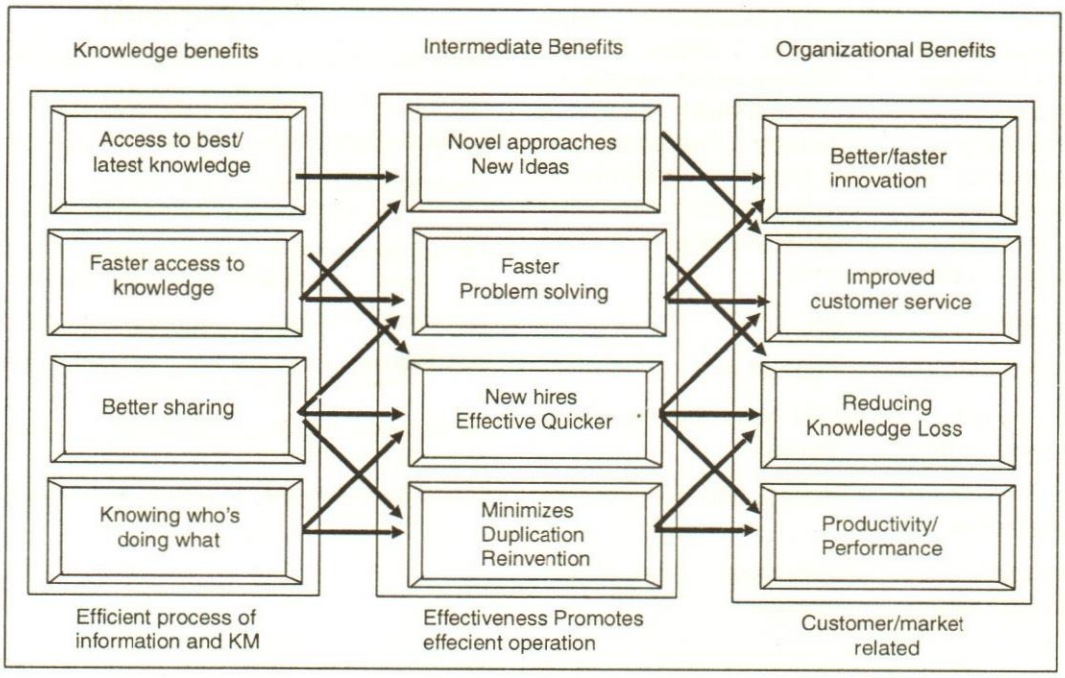


Fig. 19. Knowledge benefit

vendors specify software architecture as web-centric but the method of realization and features are also varying widely. Architecture, product development roadmap, integration compatibility, software customization capability, human resource capability size, financial stability, partners, risks and the total life cycle cost are the key evaluation criteria. Merger, acquisition, geographical dispersion, change in business strategy after acquisition and obsolescence declaration, etc are all serious concerns as KM is a long-term strategic decision.

For a comprehensive KM solution, both software tools and their implementation partners are to be carefully evaluated for their ability to deliver, support, maintain and enhance the KM solution. Capability and competency of this implementation team is critical for understanding of the business process of the organization, best practices and the software product knowledge for successful implementation.

KM Benefits

Knowledge Management benefits are significant in terms of intangible and derived tangible value to the organization and the stakeholder. Benefits are broadly classified in terms of knowledge benefits – faster access to best knowledge, intermediate benefits – promotes efficient operation and organizational benefits – faster innovation and productivity improvement, and improved customer service as shown in Fig. 19.

- *Productivity improvement* through operational innovation and excellence: KM enables an organization to reduce cycle time for new product and service development, supply, installation etc., by preventing reinvention or duplicate activity and promotes concurrent working on a task through collaboration. This approach leads to savings and reduces costly mistakes.
- *Enhanced value to Stakeholders*: Increased bottom-line and stronger revenue growth of an organization leads to satisfied employees and shareholders. Increased responsiveness to customer and partners leads to business innovation and quicker problem solving. KM enables organization to get predictive trends which lead to value added features in products and services results in customer success.
- *Competitive advantage:* KM enables organizations to forge *new opportunities* – new markets, new products and services by systematic capture and sharing knowledge from both internal and external environment (customers, prospects, markets, competition, experts). Knowledge audit and mapping process enables the decision maker to quickly respond to the business requirements.
- Improved decision-making: Auto creation of flags and Reports through knowledge discovery and knowledge mapping process.

- *Efficient Human Resource management* – organization can identify the real contributors, capture knowledge and introduce expert system for mission critical function and thereby reduce the vulnerability due to churning out of employees (resignation, retirement, transfer). *Prevention of knowledge loss* - knowledge retention. *Out-sourcing is easier* as the real knowledge is codified and not visible to the user.
- Adaptability and flexibility.
- Maximization of knowledge re-use.
- Paves way for learning for better work and may require less direct supervision.
- Improved Quality – Product and services enhancements.
- Knowledge assets development – internal process and external knowledge.

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□

In order that people may be happy in their work, these three things are needed: They must not do too much of it; and they must have a sense of success in it—not a doubtful sense, such as needs some testimony of others for its confirmation, but a sure sense, or rather knowledge, that so much work has been done well, and fruitfully done, whatever the world may say or think about it.

– W.H. Auden

Productivity and Competitiveness in the Knowledge Economy

Arundhati Chattopadhyay, G.S. Krishnan & U.S. Singh

In a knowledge economy, productivity growth depends on innovations, investment in the information and communications technology (ICT) sector and development of human capital. This paper illustrates India's present performance on the various indicators of knowledge economy, and also from the points of view of productivity and competitiveness, while comparing it to nations like China and the Philippines. There is also an outline of the macro level steps that would be required to be adopted in the transition to a knowledge economy.

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In the knowledge economy, productivity growth depends on innovations, investments in the information and communications technology (ICT) sector and development of human capital. Competitiveness is *sine qua non* of higher productivity. A firm's competitiveness is assessed by its ability to produce goods and services of the right quality, at the right price and at the right time. A firm is competitive when its total factor productivity grows so consistently that it results in reducing the unit cost of output and providing funds for the organisation's expansion plans.

The sustained growth in productivity leads to higher living standards and enhances competitiveness of a country. Therefore, a nation's competitiveness may be defined as the degree to which it can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real income of its people in the long term.

The two basic elements of competitiveness are technical costs of production (productivity) and the costs at which the goods are sold abroad (the exchange rate). Competitive advantage of a nation in the knowledge era also depends on the continuous acquisition of new skills by people and companies and being ahead of the competition in exploiting critical knowledge. Thus, in the production process, for achieving higher productivity and competitiveness the conventional tangible economic inputs of land, labour, and capital are required to be supplemented with intangible inputs of information, skill and competence. The ways in which companies, industries, and institutions manage knowledge, apply information technology, and develop systems to enhance capability and competence have surfaced as increasingly critical factors in business and economic success. Thus, the skill of efficient application of knowledge is the key to competitiveness.

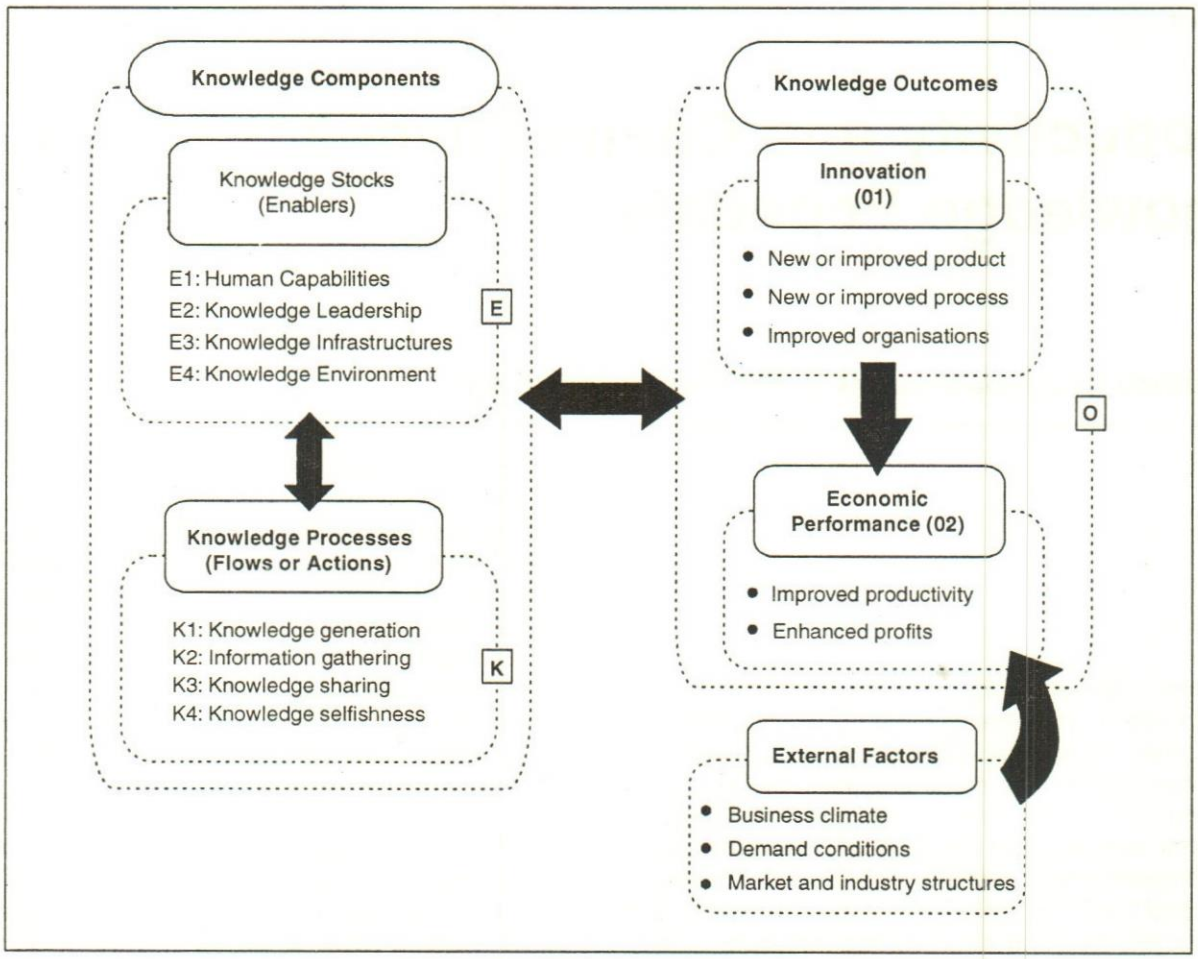

Fig. 1. Knowledge flow in an economy

Source: Shapira et al 2005)

Knowledge in the theory of Economic Growth

The theories of economic growth do not mention explicitly knowledge as a factor of production. It has always been ubiquitous in the system and contributed in enhancing productivity and competitiveness of nations. Of course, economic thinkers from Adam Smith and Karl Marx to Alfred Marshall and Joseph Schumpeter, have emphasized the significance of knowledge-dependent factors like skill, development of technology and innovation for productivity enhancement and economic development. At the macro level, economic models capture the generation of ideas and their association with wealth in the production function. The generic production function relates factor inputs like labour and capital to total output (Shapira et al 2005). The deficiency of the basic Cobb-Douglas function in handling new innovations and endogenous technical change has been dealt with in later economic models of Robert Solow (1957) and Moses Abramowitz (1956), where knowledge is seen as embodied in technological change. The "growth accounting" attempts to disaggregate the residual in the standard production function by employing increasingly sophisticated econometric methods. A more recent development is the "knowledge production function" which postulates the generation of new knowledge to be dependent on R&D capital, labour and other inputs (Shapira et al 2005).

At the firm level the knowledge capacity is proxied by means of instruments like balanced scorecards, intangible assets monitor, intellectual capital accounts, and stylized models of knowledge spillovers (Sveiby, 1997; Boudreau, 2002). In addition to knowledge stocks and flows, knowledge enablers are measured as a way of identifying practices with the potential to change or maintain knowledge stocks and flows. These may include leadership, strategy, organisational partnerships, or talent (Kermally, 2002). In this new global "knowledge economy",

emphasis is being given to information, skill and know-how and application of this critical knowledge for corporate, regional, and national economic success (Nonaka and Takeuchi, 1995; Stewart, 1997; Cooke, 2002).

The flow of knowledge in an economy is shown in Fig. 1. Innovation takes place as the knowledge enablers (E1 to E4) along with external factors like overall economic environment, market and industry structure enters into knowledge processing (K1 to K4). Application of innovations results in new products, processes and organisational changes that enhance the firm's productivity and business performance. This leads to economic growth and competitiveness of a nation.

India's Competitive Position in the Global Economy

India, often referred as the "sleeping giant," has emerged as the fourth largest market in terms of its GDP. The year 2006 marks the third year of healthy economic growth, but the development has been India's move from a "working power" based on supply of low cost labour to a "brain power" comprising a skilled and educated work force (Garelli, 2006). Table 1 shows India's position in the new global economy.

India has experienced tremendous improvement in its competitiveness ranking in the last five years. India has secured 29th rank in 2006 against 39th position in 2005 and 41st in 2002 as measured by the Switzerland-based International Institute for Management Development (IMD), "World Competitiveness Yearbook". The ranking analyses the competitiveness of 61 economies based on 312 criteria, classified into economic performance, government efficiency, business efficiency and infrastructure. The National Productivity Council (NPC), India serves as its Partner Institute and supplies information on India.

India's progress is mainly due to the positive impact of economic reforms and is reflected by the significant improvement in "economic performance" (7th in 2006 from 12th in 2005 and 17th in 2002) and "business efficiency" (19th in 2006 from 23rd in 2005 and 41st in 2002). The ranking for "government efficiency" progressed from 39th in 2005 to 35th in 2006 with the best performance in the fiscal policy. However, lack of both physical and social infrastructure (viz., basic, technological and scientific as well as health, environmental concerns and education) remains a serious challenge to the Indian economy. India's rank in infrastructure has gone down from 49th in 2002 to 54th in 2005 and remained flat reflecting lack of investment in basic infrastructure.

The increase in global trade and inflow of foreign direct investments determines a nation's competitiveness. India's rank in inward FDI performance and FDI potential index is 119 and 82 respectively among 141 countries considered in the UNCTAD's World Investment Report 2006. The performance index is based on the country's share in global FDI inflows and GDP where as potential index is based on 12 economic and policy variables. FDI inflows into South, East and Southeast Asia reached $165 billion in 2005, corresponding to 18% of world inflows, of which China ($ 72 billion) had the maximum followed by Singapore ($ 20 billion), Indonesia ($ 5 billion), Malaysia and Thailand ($ 4 billion each). Inflows into South Asia were much lower ($ 10 billion), with the highest level ever for India at $ 7 billion. In India, during the post-liberalisation period (1991-2005), 16.62 per cent of total FDI inflows were received by the electrical equipment industry including computer software and electronics. This was followed by the transport industry (10.39 per cent), telecommunication including radio paging, cellular mobile, and basic telephone services (9.60 per cent). The Indian service sector, both financial and non-financial, together constitute 9.53 per cent in total FDI inflows. Foreign investors prefer China and India as both the countries have large reserves of skilled as well as unskilled labour and cost of production is comparatively less in these two countries.

The ease of doing business in a country also determines its international competitiveness. India is positioned at 134 among the 175 countries by the World Bank's Doing Business (2006) that ranks economies on their ease of doing business based on 10 factors likes starting a business, dealing with licenses, paying taxes etc., giving equal weight to each factor. A high rank on the ease of doing business index means the regulatory environment is conducive to the operation of business. In India regulations dealing with license (rank 155), employing workers (rank 115) and registering property (rank 110) are stringent when compared to other countries. However, getting credit (rank 66) is relatively easier in India.

In this era of ICT revolution where the whole world is being knitted into a global knowledge network a nation's competitiveness is also driven by the development of its knowledge economy. The World Bank, based on its Knowledge Assessment Methodology (2006), has assessed 132 countries on the development of its knowledge economy. India ranks 103 and 97 in the Knowledge Index (KI) and Knowledge Economy Index (KEI) respectively. KI measures the country's overall ability to generate adopt and diffuse knowledge, while the Knowledge Economy Index (KEI) takes into account whether the

Table 1: India's Position in the Global Economy

Sl. No:	Country Name	Competitiveness Index (2006)	Inward FDI performance Index (2005)	Inward FDI potential Index Ranking (2004)	Ease of Doing Business Index (2006)	Knowledge Index (2006)	Knowledge Economy Index (2006)	e-government readiness Index (2005)	Human Development Index (2004)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Australia	6	111	18	8	5	7	6	3
2	Canada	7	97	3	4	10	9	8	6
3	China Mainland	19	55	33	93	75	73	57	81
4	Denmark	5	140	21	7	2	1	2	15
5	France	35	80	16	35	17	19	23	16
6	Germany	26	123	8	21	14	13	11	21
7	**India**	**29**	**119**	**82**	**134**	**103**	**97**	**87**	**126**
8	Japan	17	131	22	11	13	14	14	7
9	Malaysia	23	62	32	25	53	46	43	61
10	Philippines		115	61	126	82	78	41	84
11	Singapore	3	60	47	1	27	20	7	25
12	Sweden	14	64	7	13	1	2	3	5
13	Thailand	32	96	59	18	67	65	46	74
14	United Kingdom	21	49	2	6	9	10	4	18
15	USA	1	120	1	3	6	6	1	8

Source: Col 3: World Competitiveness Yearbook (2006), IMD Col 4-5: World Investment Report (2006),
Col 6: Doing Business (2006) WB, Col 7-8: Knowledge Assessment Methodology (2006), WB
Col 9: Global e-governance Readiness Report (2005) UN and Col 10: Human Development Report (2006)

environment is conducive for knowledge to be used effectively for economic development. KEI depends on four pillars of knowledge economy viz., economic incentive and institutional regime, education and human resources, the innovation system and ICT.

The extent of development of a nation's knowledge economy could also be assessed by the capacity and willingness of that country to use e-government for ICT-led development. The measurement of e-government is an assessment of a state's use of internet and the world-wide web (www) for provision of information, products and services plus the development level of telecommunication infrastructure and human capital in a country. The United Nation's e-government readiness index is a composite index comprising the web measure index, the telecommunication infrastructure index and the human capital index. In the Global e-government Report 2005, India has been ranked 87th among the 191 UN member countries and has slipped one point in the relative ranking as compared to the previous year. This decline in ranking does not necessarily imply that India's effort towards e-governance was less, but is clearly an indication that the gainers performed better.

Limited e-government development is the result of a lack of financial resources, with more basic needs such as education, healthcare etc. as the emergent priorities for India. Moreover, a large proportion of the rural population remains without electricity and telephone. This may be attributed to high access costs, poor infrastructure and the slow pace of deregulation that have affected the growth of ICTs, in general, and the Internet in particular. Where access is available, lack of literacy and technical skills pose limiting constraints on the demand for e-services. As a result, newer technologies remain the domain of the elite in most of the regions in the country. Of course, India has recently added a policies portal (http://policies.gov.in/) where agencies and departments are able to publish their policies for the public to view. This is a definite step towards broader inclusion. However, India needs to make extra efforts to expand and fortify the e-government services so that its relative performance in the world improves in the coming years.

Table 2: Labour Productivity in the knowledge economy

Sl. No:	Country	Labour Productivity (GDP per person employed (1990 US$))					Average annual growth rate of labour productivity (1999-2003)	Elasticity of employment to GDP (1999-2003)	Average annual GDP Growth Rate % (1999-2003)
		1999	2000	2001	2002	2003			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Australia	46184	45943	47190	47759	48466	1.4	0.6	2.7
2	Canada	45915	47668	47896	48383	48214	1.1	0.4	2.9
3	China Mainland	6357	6800	7216	7739	8380	6.8	0.2	8.1
4	Denmark	43240	44351	44942	45602	46275	1.6	na	1.7
5	France	51578	52122	52271	52587	52943	0.6	0.6	1.9
6	Germany	40826	42308	42533	42904	43272	1.3	0.1	0.9
7	**India**	**4955**	**5046**	**5195**	**5434**	**5781**	**3.8**	**0.4**	**5.3**
8	Japan	40385	41604	42006	42400	43049	1.5	0.2	1.6
9	Malaysia	18549	19199	19080	19480	19812	1.5	0.7	4.6
10	Philippines	6564	6952	6608	6862	6877	0.8	0.8	4.4
11	Singapore	43939	43389	43561	45150	45277	1	0.6	2.8
12	Sweden	42308	43631	43330	44114	44830	1.3	0.5	2.3
13	Thailand	11766	11985	12064	12428	13107	2.5	0.4	4.8
14	United Kingdom	41772	43836	44469	44909	45648	2	0.4	2.3
15	USA	34293	58557	58939	60198	61730	1.2	0.2	2.3

Source: Col 3: KILM (3rd Ed.), Col 4-7, Col 9-10: KILM (4th ED.), Col 8: Calculated from Col 3-7.

The development of human capital is a necessary condition for the development of a knowledge economy. India's rank is 126 among 177 countries considered in the UNDP's Human Development Report 2006.

Productivity Scenario in the Knowledge Economy

A nation's prosperity in this knowledge era is determined by its labour productivity that is defined as output per labour input. Output is measured as "value added" or "Gross Domestic Product". In order to compare economies, gross labour productivity levels are converted to US dollars on the basis of adjusted purchasing power parity (PPP). The employment elasticity provides a numerical measure of how employment growth varies with growth in economic output. The employment elasticity is defined as the average percentage point change in employment for a given population group associated with a percentage point change in output (represented by total output as measured by GDP) over a selected period. Analysis of table 2 shows that China has a very high rate of economic growth (8.1%), but has experienced relatively low employment elasticity during the period 1999-2003. It is well reflected in China's robust labour productivity growth. India also grew fairly rapidly between 1999 and 2003, but, owing primarily to its rapid labour force growth, it requires higher employment elasticity than China to avoid its growing unemployment.

Building a Knowledge Economy

The four basic requirements for building a knowledge economy as suggested by the World Bank:

1. *Creating an appropriate economic incentive and institutional regime* that encourages the widespread and efficient use of local and global knowledge in all sectors of the economy, that fosters entrepreneurship, and that permits and supports the economic and social transformations engendered by the knowledge revolution;

2. *Creating a society of skilled, flexible and creative people*, with opportunities for quality education and lifelong learning available to all, and a flexible and appropriate mix of public and private funding;

3. *Building a dynamic information infrastructure*, and a competitive and innovative information sector of the economy, that fosters a variety of efficient and competitive information and communications services and tools

available to all sectors of society. This includes not only "high-end" information and communication technologies (ICTs) such as the Internet and mobile telephony, but also other elements of an information-rich society such as radio, television and other media, computers and other devices for storing, processing and using information, and a range of communication services.

4. *Creating an efficient innovation system* comprising firms, science and research centres, universities, think tanks and other organisations that can tap into and contribute to the growing stock of global knowledge, adapt it to local needs, and use it to create new products, services, and ways of doing business. Designing and implementing a coherent and sustained response to these challenges is not easy, particularly for developing countries and countries in transition, which face additional burdens from limited resources, weak institutional capacity, and a legacy of centrally-controlled economic development.

Table 3: Development Ranking of India's Knowledge Economy

Sl. No.	Country	KEI	KI	Economic Incentive Regime	Innovation	Education	ICT
1	Australia	7	5	21	12	4	8
2	Canada	9	10	11	9	12	18
3	China Mainland	73	75	69	65	85	75
4	Denmark	1	2	5	4	2	2
5	France	19	17	26	20	14	25
6	Germany	13	14	17	13	22	14
7	**India**	**97**	**103**	**89**	**76**	**103**	**108**
8	Japan	14	13	22	6	20	23
9	Malaysia	46	53	40	59	77	37
10	Philippines	78	82	63	93	67	79
11	Singapore	20	27	1	7	70	10
12	Sweden	2	1	12	1	5	1
13	Thailand	65	67	59	68	65	63
14	United Kingdom	10	9	13	16	13	4
15	USA	6	6	15	3	16	13

Source: World Bank (2006)

The study by the World Bank's knowledge development group is an eye opener for the policy makers of India. As against the popular notion that India has a well developed knowledge economy and competitive advantage in most of the knowledge indicators, it is clear from table 3 that India is not only far behind the developed countries but has much to catch up with other Asian countries.

Table 4 gives a comparison of India's knowledge indicators with two other economies, namely China and Philippines. China's knowledge economy is more well developed than that of India and the Philippines. However, India is better off than both China and Philippines in some innovation system indicators like availability of venture capital, private spending on R & D, firm level technology absorption and the presence of a well developed value chain. India has higher public spending in education and internet access in school. The extent of staff training as well as quality of science and mathematics education and management education is also better in India. However, Philippines is better than its competitors with respect to adult literacy and enrolment in secondary and tertiary education. The ICT expenditure as a percentage of GDP is higher in rhe Philippines and it is reflected to some extent in the development of ICT support systems like telephones and computers, per capita, as well as extent of internet usage for business.

India's Competitive Advantages and Disadvantages in the Knowledge Economy

In the last five years, though India's economic growth has been encouraging, its relatively lower GDP per capita may be a disadvantage for the knowledge economy. India's top 10 per cent of the population makes 28 per cent of its national income while the bottom 10 per cent makes only 4 per cent. India has 80 per cent of its population living on less than $ 2 a day and 35 per cent on less than $ 1 a day. India is also challenged with illiteracy, low pupil-teacher ratio and medical professionals per 1000 population. As a result, majority of Indians are not able to take benefits of the competitive advantage in the cost of access to internet and mobile telephones. Thus, lower computer per capita, percentage of internet users and mobile subscribers are hampering the growth of the knowledge economy.

India's competitive advantage lies in the availability of skilled manpower in terms of absolute numbers. This is mainly because India's huge population and labour force as a percentage to the total population is not encouraging. The service sector in India is accounts for 54.1 per cent of the GDP in 2005-06 and India's share in the world commercial services was 1.9 per cent. The growth in the Indian service sector may be attributed to its competitive advantage in working hours, compensation levels i.e., the remuneration of service professionals as well as management. However, factors like corporate

Table 4: India's Knowledge Indicators vis-à-vis China and Philippines

	India	China	Philippines
Innovation System			
FDI Outflows as % of GDP, 2000-04	0.22	0.20	0.09
FDI Inflows as % of GDP, 2000-04	0.68	3.89	1.26
Royalty and License Fees Payments (US$ mil.), 2004	420.80	4496.60	270.00
Royalty and License Fees Payments (US$/pop.), 2004	0.40	3.47	3.31
Royalty and License Fees Receipts (US$ mil.), 2004	25.20	236.40	12.00
Royalty and License Fees Receipts (US$/pop.), 2004	0.02	0.18	0.15
Science and Engineering Enrolment Ratio (%), 2004	22.14	n.a	24.70
Science Enrolment Ratio (%), 2004	15.62	n.a	12.35
Researchers in R&D, 2004	117528.00	926252.00	3750.00
Researchers in R&D / Mil. People, 2004	119.00	708.00	48.00
Total Expenditure for R&D as % of GDP, 2004	0.85	1.44	0.11
Manufacturing. Trade as % of GDP, 2004	15.29	50.35	61.53
*University-Company Research Collaboration (1-7), 2006	3.30	3.90	2.70
Scientific and Technical Journal Articles, 2003	12774.00	29186.00	179
Scientific and Technical Journal Articles / Mil. People, 2003	12.00	22.65	2.23
*Availability of Venture Capital (1-7), 2006	4.20	2.90	2.6
Patents Granted by USPTO, avg 2001-05	316.40	448.20	19.60
Patents Granted by USPTO, avg 2001-05	0.30	0.35	0.24
High-Tech Exports as % of Manuf. Exports, 2004	4.90	29.80	63.80
*Private Sector Spending on R&D (1-7), 2006	3.80	3.60	2.90
*Firm-Level Technology Absorption (1-7), 2006	5.50	5.00	4.40
Value Chain Presence (1-7), 2006	4.80	3.80	4.40
ICT			
Total Telephones per 1,000 People, 2004	84.50	499.40	445.60
Main Telephone Lines per 1000 People, 2004	40.70	241.10	42.10
Mobile Phones per 1,000 People, 2004	43.80	258.30	403.50
Computers per 1,000 People, 2004	12.10	40.90	45.10
Households with Television (%), 2004	37.00	91.00	76.40
Daily Newspapers per 1,000 People, 2000	60.00	59.00	n.a
International Internet Bandwidth (bits per person), 2004	11.40	57.40	39.40
Internet Users per 1,000 People, 2004	32.40	72.50	53.90
Price Basket for Internet (US$ per month), 2003	8.70	10.10	17.00
*Availability of e-Government Services (1-7), 2006	3.55	3.96	2.74
*Extent of Business Internet Use (1-7), 2006	3.80	3.50	3.90
ICT Expenditure as % of GDP, 2005	5.91	5.28	7.00
Education			
Adult Literacy Rate (% age 15 and above), 2004	61.00	90.90	92.60
Average Years of Schooling, 2000	5.06	6.35	8.21
Gross Secondary Enrollment, 2004	53.50	72.50	85.90
Gross Tertiary Enrollment, 2004	11.80	19.10	28.80
Life Expectancy at Birth, 2004	63.50	71.40	70.80
*Internet Access in Schools (1-7), 2006	4.00	3.80	3.90
Public Spending on Education as % of GDP, 2003	3.30	2.10	3.2
Prof. and Tech. Workers as % of Labor Force, 2004	n.a	n.a	7.09
8th Grade Achievement in Mathematics, 2003	n.a	n.a	378.00
8th Grade Achievement in Science, 2003	n.a	n.a	377.00
*Quality of Science and Math Education (1-7), 2006	5.70	4.20	2.40
*Extent of Staff Training (1-7), 2006	4.50	3.50	4.10
*Quality of Management Education (1-7), 2006	5.90	3.50	5.00
*Brain Drain (1-7), 2006	3.60	3.80	2.30

Source: KAM 2006, World Bank

Note: * is based on the statistical score on a 1-7 scale of a large sample group in a particular country responding to the question

Table 5: India's Competitive Advantages and Disadvantages

	Advantages	Disadvantages
Economic Performance	Relocation of R&D facilities is not a treat to the future of your economy (survey)	GDP (PPP) per capita Estimates : US$ per capita at purchasing power parity
	Relocation of services is not a treat to the future of your economy (survey)	GDP per capita US$ per capita
	Relocation of production is not a treat to the future of your economy (survey)	Portfolio investment assets US$ billions
	Cost of living index (Index of basket of goods & services in major cities, excluding housing (New York=100)	Export of goods (% of GDP)
	Resilience of the economy to the economy cycle is strong (survey)	Trade to GDP Ratio (Export + Imports) /(2*GDP)
Govt. Efficiency	Effective personal income tax rate (% of an incomer equal to GDP per capita)	Bribing and corruption do not exist in your economy (survey)
	Employees social security contribution rate compulsory contribution as a % of an income equal to GDP per capita	Corporate tax rate on profit Maximum tax rate, calculated on profit before tax
	Employer's social security contribution rate compulsory contribution as a % of an income equal to GDP per capita	Government budget surplus/deficit % of GDP
	Management of public finances over the next two years is likely to improve (survey)	Country Credit rating on a scale of 0-100 assessed by the Institutional Investor Magazine ranking
	Total reserves including gold and official reserves (gold=SDR 35 per ounce)	Start-up days Number of days to start a business
Business Efficiency	Remuneration in services professions (Gross annual income including supplements such as bonuses in US$)	Overall Productivity Estimates: GDP (PPP) per person employed US$
	Working hours (Average number of working hours per year)	Female labour force (%of total labour force)
	Compensation levels (Estimates: Total hourly	Value traded on stock markets US$ per capita
	Skilled labour is readily available	Unit labour costs in the manufacturing sector % change
	Remuneration of management Total base salary plus bonuses and long term incentives, US$	Labour force (% of population)
Infrastructure	Mobile telephone costs Prepaid cellular tariffs-US$ per 1 minute (local)	Pupil-teacher ratio (primary education) Ratio of students to teaching staff
	Qualified engineers are available in your labour market (survey)	Medical assistance (no. of inhabitants per physician and per nurse)
	Science in schools is sufficiently emphasized (survey)	Mobile telephone subscribers (No. of subscribers per 1000 inhabitants
	Youth interest in science is strong (survey)	Internet users (no. of internet users per 1000 people
	Internet costs cost for 20 hours dial up per month, US$	Computer per capita (No. of computers per 1000 people)

Source: IMD 2006

tax on profit, unit labour cost in manufacturing and number of days required to deal with licenses, register property and start a business are acting against the growth in the manufacturing sector. This needs to seriously dealt with for sustainable growth of knowledge economy.

In this knowledge economy India's competitive advantage lies in its vast pool of young population (0-14 years), who constitute almost 33 per cent of total population. This human resource needs to be developed to meet the global demand for human capital. Analysis of table 6 shows that there is already a decline in the availability of skilled manpower in terms of qualified engineers and competent senior managers. Decline in total public expenditure on education would further aggravate the shortage of skilled manpower. Moreover, inadequate and inefficient energy infrastructure, lack of technological cooperation between companies, paucity of funds for

Table 6: India's Improvements and Declines in 2006 as compared to 2005

Improvements	Declines
Direct investment flows abroad (US$ billions)	Portfolio investment assets US$ billions
Direct investment flows abroad (% of GDP)	Current account balance (% of GDP)
Mobile Telephone Subscribers (No. of subscribers per 1000 inhabitants)	Terms of trade index (unit value of exports over unit value imports (2000=100)
Exports of Commercial Services (US$ billions)	Consumer price inflation (Average annual rate)
Broadband Subscribers (No. of subscribers per 1000 inhabitants)	Energy infrastructure is adequate and efficient in your economy (Survey)
Exports of Commercial Services % of GDP	Technological cooperation developed between companies (survey)
Internet Users (No. of internet users per 1000 people)	Collected total tax revenues (% of GDP)
Value Traded on stock markets (US$ per capita)	Total public expenditure on education (% of GDP)
Direct Investment stocks abroad (US$ billions)	Skilled labour is readily available (survey)
Computers per capita (No. of computers per 1000 people	Technological regulation supports business development and innovation (survey)
Direct Investment stocks inward (US$ billions)	Funding for technological development is generally sufficient (survey)
Trade to GDP ratio (Export + Imports)/(2*GDP)	Real corporate taxes do not discourage entrepreneurial activity (survey)
Direct investment flows inward (US$ billions)	Cost of living index (Index of basket of goods &services in major cities, excluding housing (New York=100)
High-tech exports (US$ millions)	Qualified Engineers are available in your labour market (survey)
Stock market capitalization (% of GDP)	Competent senior managers are readily available in your labour market (survey)

Source: IMD 2006

technological developments and enabling technological regulations supporting business development and innovations are hampering India's growth in the knowledge economy. Hence, policy makers need to give due attention towards development of human capital and technological advancement.

India's growth in the knowledge economy is marked by its improvements in factors like stock market capitalization, FDI, exports of commercial services as well as high tech exports. There is also an increase in the absolute number of broadband subscribers and internet users and computer per capita but the present rate of growth in these factors is not sufficient for India's competitiveness.

Steps Needed to Develop a Competitive Indian Knowledge Economy

In this knowledge era, enhancing competitiveness and productivity in industry as well as of nations has become a challenge for all developing nations, including India. The government's recent economic and industrial policy focuses on the role of knowledge and its relationship to innovation and the application of new 'knowledge activities' and technologies for economic development of the nation. The following broad framework of actions are suggested by the World Bank Report for strengthening Knowledge Economy. India could benefit by following these:

Create an Enabling Environment

Through suitable policy interventions in the legal and regulatory frameworks, financial systems, labour market, social safety nets and accountability of the Government.

Development of Human Capital

Decentralising initiative, responsibility and accountability for education at all levels, and creating opportunities and incentives for investment and innovation in education and creating opportunities for lifelong learning.

Infrastructure Development

Fostering competition and private sector investment in information infrastructure and services and development of professional regulatory meachanisms; also promotion of access to ICT tools by a large section of the population by making them affordable.

Innovation System

Creating a strong and effective national innovation system and promoting research and development that brings innovations to market; and encouraging greater interaction and cooperation among firms, universities, government and private research organisations, and greater contact with their foreign counterparts.

Application Potential for Knowledge Management in India – The Future Road Map

The present Project on "Enhancing the National Competitiveness in the Emerging Indian Knowledge Economy" is expected to bring out and suggest solutions for the future application potential of Knowledge Management in India. The broad spectrum in which research is likely to be conducted with an aim to bringing out implementation-based solutions are described below:

Mapping the directions and trends of the transition to the knowledge era

Mega Trends of the various sectors towards Knowledge era would be required to be identified and these would have to be compared to similar patterns of other Nations. Such trends should also consider strengths and opportunities in the ICT sector and threats from neighbouring competitors like China. These trends should also bring out the likely impact of the transition on the social structures and institutions and corrective actions required to reduce stresses and tensions.

Strategies for change management

The transition to Knowledge based Economy is likely to bring considerable pressure on the convention and tradition based working styles of the hitherto orthodox systems in the Government and Corporate enterprises. Hence Change Management assumes an important role to reduce the undulations in the transient phenomenon. It would be required to identify proper measurement indices which reflect correctly the productivity and competitiveness performance at various phases of the transition and change and present balanced and transparent information on the benefits so that support of all stakeholders is obtained for the Change to the Knowledge Economy. The strategies to achieve the planned levels of performance indices will emanate from such new thinking.

Identifying new knowledge streams/disciplines

A host of new knowledge streams/disciplines like bio-informatics, nano-technology, use of ICT in traditional medicine, green energy and productivity, environmental sustainability etc., are likely to emerge to cater to the emerging needs of the future and these streams that will be applicable in the Indian context need to be identified through consensus. Our educational and vocational institutions need to take pro-active action on developing the course curricula and delivery mechanisms to prepare our human resources attain proficiency in such emerging streams and disciplines.

Stakeholders' awareness to issues relating to knowledge economy

India has the inherent difficulty of unreliable connectivity amongst its vast masses, both in physical form and spiritual form; hence developments leading to productivity and competitiveness remain as islands of selected nodes with the remaining networks unaware of such transitions. It would be required to design and evolve a mechanism to develop communication methodologies to which would enable a continuous and easy communication to various stakeholders in the country. Suitable technologies taking into care the peculiarities of the Indian sub continent also need to dovetail into such methodologies.

Creating a network of knowledge institutions

The advent of the "Internet" has made it considerably easy and flexible to network amongst various individuals and institutions at a global level. There are many successful cases of such web-based networks which are able to create transnational advantageous positions to various stakeholders. In India, the penetration of the Internet to the grassroots level of the masses is still not up to the mark. Hence, there is a necessity to consider creation of various other forms of knowledge networks like "community of practices", formal institutional arrangements etc. There should be "win-win" results to all the partners of such networks so that they can sustain on a continuous basis.

Knowledge management towards the larger good of the society

The larger proportion of the Indian economic sectors still lies in the unorganised forms. Agriculture continues to occupy more than half of the working population, where, due to the small land holding pattern, the fruits of the knowledge-based productivity developments are yet to be adopted on a larger scale. Small, medium and micro industries constitute a very large chunk of our manufacturing sector, which need massive inputs of productivity to enhance their competitiveness in the light of new

WTO stipulations. There are also many public service paradigms like citizen services, health, education, tourism etc, which need transformation using knowledge management tools.

Conclusion

This paper has brought out the fundamentals of the economic growth and theories that correlate knowledge development to such growth. India's present performance on the various indicators of knowledge economy, and also from the points of view of productivity and competitiveness, has also been illustrated. Its strengths and weaknesses compared to nations like China and the Philippines and the strategies that it should adopt to leverage its strengths, have been indicated. Finally, the paper brings out the macro level steps that would be required to be adopted in the future towards a painless transition to the inevitable "knowledge economy."

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You can discover more about a person in an hour of play than in a year of conversation.

– Plato

Knowledge Management in Product Lifecycle

V. Venkata Ramana

A product lifecycle is a golden thread which gives continuously enhancing value to the product or business. From the inception stage where there is a concept about the product, to when it becomes more robust, the knowledge about the product matures at each stage. Effective knowledge management systems capture this knowledge. This paper shows how essential KM systems are to each organisation, especially those dealing with long lifecycle products such as turbo machinery, aircrafts, plant machinery etc.

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The Golden Thread of Product Lifecycle

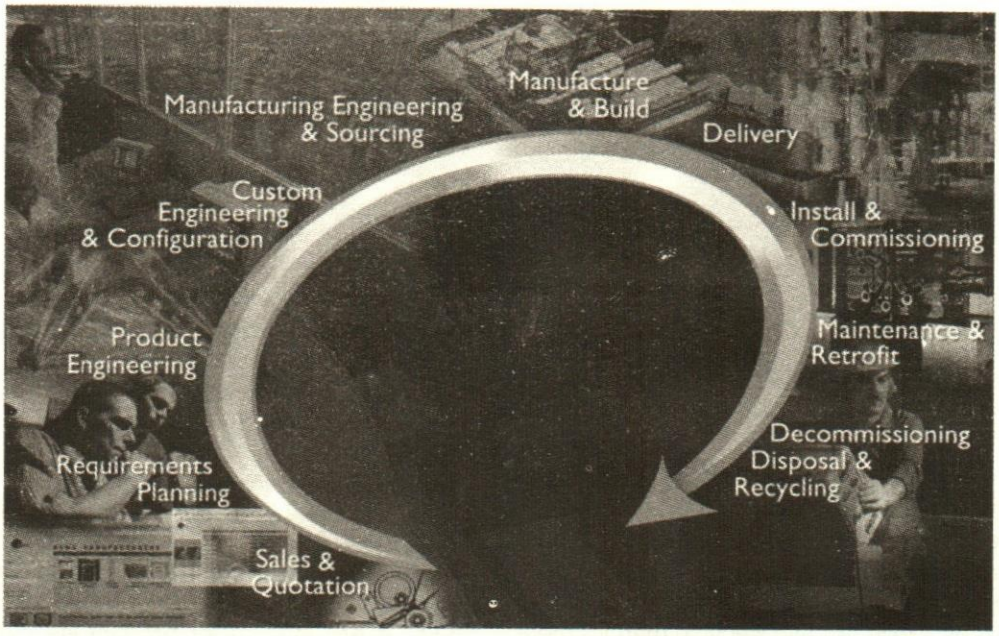
A product lifecycle is a golden thread which, if laid properly, gives continuously enhancing value to the product or business at each step in the cycle and even into next cycles. A good knowledge management system is a framework that weaves this golden thread.

Figure 1 indicates how each step in the product lifecycle from market/sales inputs, requirement planning, and so on till, maintain, retrofit, decommission and dispose, connect and follow a golden thread. As products go through this golden thread, ideas gain momentum as they are analysed and they sharpen, enlargen, challenge or propagate. The cycle is dizzying in pace, process and the final product is then fed back into the flow cycle for continual iteration.

While following the golden thread we need to bear in mind that, "We do not consume knowledge as a passive entity that remains unchanged as it moves though our world and work. We dance and court the knowledge of others (engineers) – in ways that the original creators (engineer) did not intend. We make it ours and in doing so diminish the prominence of the originator."

Therefore in a product development cycle (the golden thread), knowledge of the product matures at each of the steps and as the next cycle begins, the golden thread provides a rich legacy knowledge for the next product cycle, sometimes feeding into a completely new product cycle.

This knowledge legacy, if weaved as a process into the culture of an organization and made available and applied, makes knowledge organizations differentiate themselves from the rest. The challenge is therefore to begin the product cycle at each step with an explicit intent and purpose, and strive for continuous improvement



Courtesy UGS

Fig. 1. The Golden Thread of Product Lifecycles

as a process. Most management initiatives like TQM, Six Sigma and Lean Management, actually would work with such a Knowledge Management (KM) system, whether explicitly built or implicitly followed.

As per an AMR report, "52% of the new products do not meet customer needs and die in the cradle". The primary reason for this is non-application of engineering intelligence which needs to integrate into design and manufacture of the product. From a process management perspective, even in well managed organizations, "74% of the product development is formally managed and 26 % of the data is floating around loosely". Hence there is a need of a good KM system to manage engineering knowledge & intelligence which then is interleaved with PLM systems that manage processes and engineering information/data.

Let us now examine the lifecycle stages of a product, from cradle to grave, and see how KM becomes the core central theme on which the cycle works and impacts them at each stage.

The lifecycle of a product begins from the time you conceptualize a product, create a clear requirement definition and build the first prototype. The motivation to conceptualize a new product arises from:-

(a) an idea or an opportunity arising out of an idea

(b) market needs

(c) mere growth or survival in business. Successful products have a much sharper definition prior to development.

Each of these originates from a knowledge source. The process of ideation and thereby innovation requires, in addition to collection of facts, hypotheses, their connections and correlations and experiences. This is the toughest challenge for KM, since ideas do not arise without connections and correlations amongst seemingly unconnected facts or hypothesis. Where facts and moreso, hypothesis, are challenged, the ideation process is further time-consuming.

The other two motivations, namely market need and growth, require a reactive usage of structured knowledge, a collections of facts and figures laid out systematically in a structure. Conceptualizing a new product here requires digging into this structured information and pulling out relevant data, and putting them together in a previously known process. The data, structure and process are relatively known and possibly established. For an intelligent observer these are tweaked products or improvisations, rather than innovations.

From this cradle phase, concept products develop to become a robust product through revision, versions. The knowledge about the product matures at each of these stages. Effective KM systems capture this knowledge not merely as data but as key values, added to the product

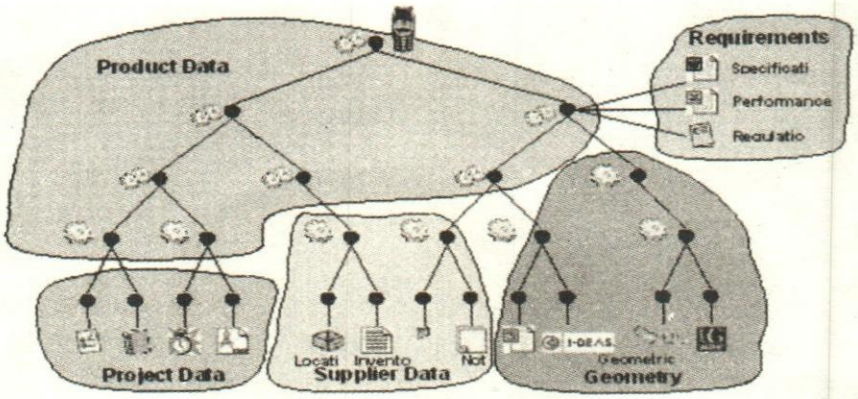


Fig. 2. Product information repositories

as it becomes robust. Constant user or market feedback on performance of the product helps in bringing about these changes or improvements. Nearly half of the "product differentiator" values are added to the product during these update stages. While product lifecycle management products manage tasks in product engineering like version controls, product releases, etc, the KM system focuses on know-why, know-what and know-where. This is truly organisational knowledge and not product knowledge captured in the system.

KM systems in this case can also help in thinking one step further than what the market demands, so that the market lead (market share) in the market does not erode. KM perhaps even helps in increasing it.

Integrating Knowledge Management into Product Lifecycle

The following picture indicates how knowledge data can be captured, integrated and maintained as a central system serving a set of computer based solutions for requirement definition, systems engineering, digital engineering, digital factory, manufacturing simulation and maintenance management. The golden thread can be simulated through multiple cycles in virtual mock-up scenarios without actually going through real world product cycles.

In the above example, a digital model (3 Dimensional CAD) model is created out of requirement definition, and taken through virtual engineering, followed by manufacturing simulation etc. The product knowledge management system becomes the core of such integrated systems.

"Engineering knowledge is dynamic and does not often have standard solutions to a problem. Engineering problem solving switches between analysis and synthesis phases. Analysis results in new requirements and in control knowledge about how to proceed and is dependent on common sense knowledge which can be modeled." A KM system for product life cycle enables this intensive iterative process of engineering integrated into the controlled knowledge and common sense knowledge.

KM systems are increasingly essential for long lifecycle products, like turbo machinery, aircrafts, plant machinery etc., during product maturing phase. In these cases, it becomes important to capture and retain knowledge of original intent of design, the observed behaviour as against the design intent, and learning what goes into improvement changes. Since this information goes through multiple experts, some of whom may move out or retire from current jobs, it is important to capture this sometimes implicit knowledge through systematic process. Capturing know–why and using it in knowledge networks subsequently, attains greater importance in this case. Creation of knowledge networks that match the complexity and life of the products is another challenge in these cases.

In short-lifecycle products like electronic products, the situation is best described by this statement from Dr Goldtratt, "Look at electronic industry. The pipeline has three to five months whereas the lifetime of product is six months. It would be a fantastic joke if it weren't a reality". For these industries, KM systems have to be simple and agile. The benefits of KM can be seen only after a few cycles of following the golden thread. These industries tend to be sourcing-centric rather than manufacturing-centric. Visibility into impending demands from customers is necessary to set the right time supplies.

After several versions in its lifetime, products go to the grave, but leave behind a rich legacy of important

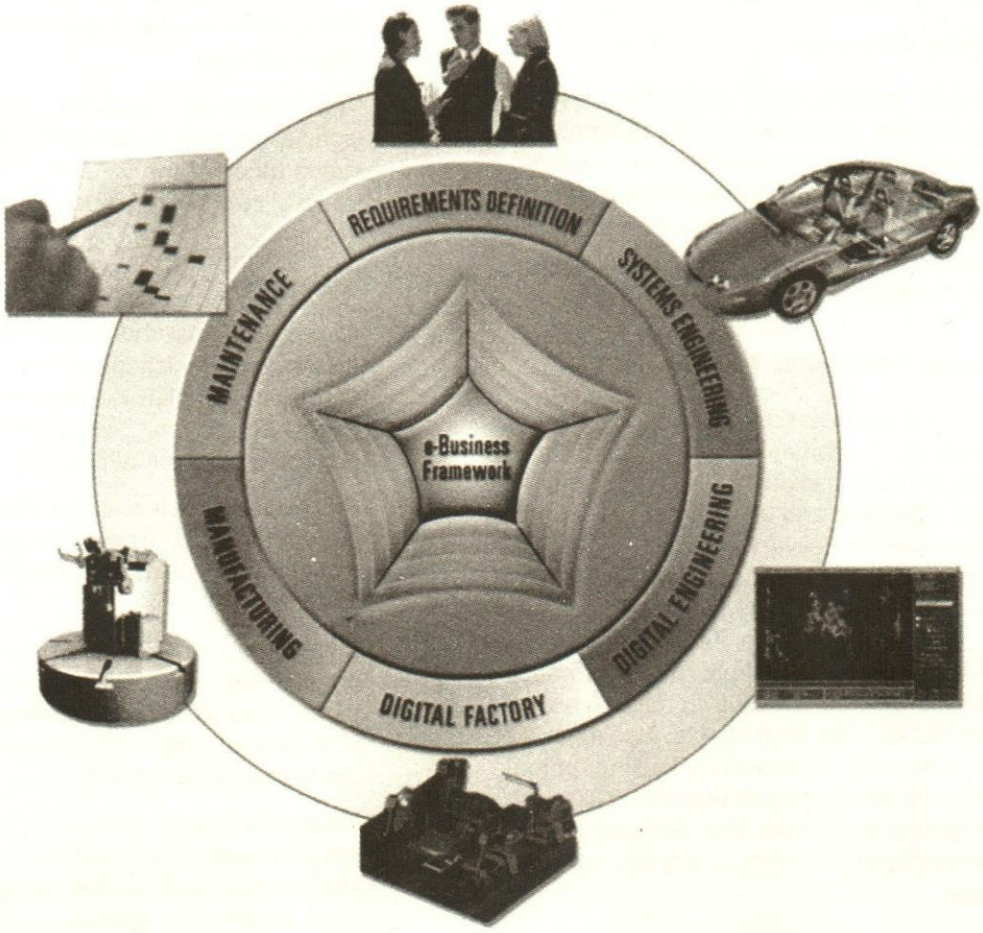


Fig. 3. Knowledge at the core in a virtual design to manufacture system

knowledge for posterity if captured in a KM system and re-used for new products. Knowledge-based economies retain their competitiveness through this rich pool of knowledge captured and managed, implicitly or explicitly in their organisations.

Tools and Technologies

There is no single technology or solution that fits all type of industries or products. We do have several proven PLM products like SAP, Teamcenter, Enovia, Windchill, e-matrix, and Agile which serve the PLM market. They meet the data management and process (workflow) requirements of product lifecycles. However, they fall short of becoming true KM solutions by themselves. Hence it is important to weave these PLM implementations into a custom KM solution. Also, the knowledge needs are different at each of the stages of the product lifecycle. Also depending on the product's life e.g. a use-and-throw ball pen vs a long-life turbine, the Knowledge Management systems call for different requirements or even different definitions.

Similarly, where organisations are becoming global, for manufacturing, sourcing or supplying, the scope, purpose and complexity of KM systems required increases. Automobile OEMs, which source products from multiple suppliers, need to ensure tightly interfaced systems to their own product knowledge and designs, without revealing too much to the suppliers. Similarly suppliers supplying parts to multiple automotive OEMs have to be discrete and honour IPRs and manage products intended for each OEM.

Hence KM systems have to be tailored for each organisation based on its own market position, products, suppliers, customers and lifecycle of products. Internal factors to be considered are processes, organisational divisions, and culture/environment in the organisation.

Typically intellectual capital (Knowledge) within an organisation helps in:-

(a) Product Excellence

(b) Business Transformation and

(c) Operational excellence.

All are aimed at "improvements' rather than true "innovations'. Collaborative framework in KM systems creates enhanced flexibility in communication, provides process enhancement, consistency, repeatability and reusability of Knowledge. It also helps in identifying and setting up processes for progressive elimination of delays, through process redesign and process automation.

Innovation through Knowledge Management

How much of innovation can be aided by Knowledge Management systems is another issue that needs to be examined. So far, our discussion focused on capturing information at the right time and enabling re-use at right stage with right knowledge delivery capability in the processes. Some intelligence and adaptability can also be brought in system level pattern recognition and connections based on historic experience. Technology investment in such KM systems merely improves performance and brings about improvements. However, rapid advance in technology diminishes long-term effects. Also most so-called efforts for innovation are inwardly looking, primarily aiming at cost reduction, higher throughput in all tasks, lowering cost of quality, etc. These may give competitive parity, but transformational innovation is required for competitive advantage.

Let us examine an APQC report (Using Knowledge Management to Drive Innovation) that was prepared by a team which includes some of KM's most articulate champions, including the Centre's president Carla O'Dell, and HBS Professor Dorothy Leonard, author of one of the books that put KM on the business map, Wellsprings of Knowledge. The report was made after a study of seven organisations, including NASA, 3M and the World Bank, to ascertain the connection between KM and innovation. There were 15 key findings:-

1. Quality KM systems are more likely to improve the *efficiency* of the innovation process, than to actually produce *more or better* innovation.
2. Innovative organisations are challenged with managing more and more complex, technical, scientific and cross-disciplinary information than other organisations, and KM can improve and streamline this management.
3. KM tools and repositories are more essential in innovative organisations, and IT plays a bigger and more strategic role in such organisations as a result.
4. Innovative organisations are more aware of what KM is and the value it delivers compared to other organisations.
5. Innovative organisations have a cultural bias against reusing information, which greatly mitigates much of the value that what we currently call KM can bring to such organisations.
6. A critical requirement in innovative organisations is expertise locators.
7. Because of the importance of cross-functional and trans-organisational collaboration in innovation, social capital (know-who) - not structural capital (know-what) - is their most critical component of intellectual property.
8. KM was of greatest value when it was pushed out, just-in-time, 'where the people who need it would trip over it' (rather than having to go look for it).
9. Innovative organisations use communities of practice and virtual teaming extensively and explicitly, and allow communities and linkages to form naturally rather than mandating and structuring their organisation.
10. Innovative organisations have explicit awareness programmes, best practice and success story identification and publicity programmes, and reward systems to achieve knowledge behaviour change.
11. In recruiting, innovative organisations explicitly seek out people with high creativity, exceptional problem-solving skills and willingness to share what they know.
12. Innovative organisations coordinate their KM and learning programmes and infrastructure.
13. Innovative organisations identify strategic external partners and extend the enterprise and its tools and resources to incorporate these partners.
14. KM infrastructure in innovative organisations has three balanced, coordinated components: Advisory and sponsorship groups, a core 'knowledge centre' of full-time information professionals, and representation and liaison with knowledge-savvy representatives in all of the 'internal customer' business units.
15. No one has yet solved the problem of measuring KM success in ways that irrefutably or even compellingly show its contribution to innovation

and achievement of organizations' other high-level strategic objectives. It is obvious from the above findings that for creating a disruptive innovation, KM's use of an information system which extrapolates history to imminent events, can be a barrier. In fact a mere information gathering KM system inundates with sensory overload. Transformational innovation is also as much dependent on "imagination" as on knowledge.

To become imaginative and therefore innovative, knowledge needs to be internalized by the receiver and force him to see a big picture. Classification or fragmentation of engineering knowledge as means to reduce cognitive load, ends up more taxing when it fails to accurately reflect the big picture. Seeing the big picture requires viewing from multiple perspectives, as seen by multiple individuals. For this, instead of a transaction-oriented design process, KM processes should facilitate a shared model for knowledge flow, where an engineer can share multiple perspectives (of design intent and use) of the same object as seen by each engineer and come up with the big picture. Innovation can happen from this knowledge of the big picture and combined with the knowledge stemming from events and ideas of the whole golden thread. The same cannot be achieved by providing a rich comprehensive source of information at each process step. Finally, the culture and values have to be interwoven into this golden thread as well.

Therefore there are five important components for the success of KM systems in product innovation and product lifecycle:-

(a) Information management and retrieval: This is akin to business intelligence systems but with a difference. Product development cycle is iterative process unlike business processes, and therefore requires constant cleaning up of outdated knowledge to avoid overload in KM processes.

(b) Adaptive learning/predictive models: Where possible, the KM system should create relationships amongst knowledge content and apply to appropriate knowledge networks.

(c) Computing systems and solutions: One has to set-up a PLM solutions to integrate into a KM framework, running through the golden thread.

(d) Cognitive psychology: We spend much of our time in containers that we create. Most often we are not thinking, but sorting and filtering. True knowledge refers to the knowledge recipient being receptive and internalizing knowledge, and then applying it. Cognitive knowledge comes to us though a network of prejudices, opinions, hypotheses, mental models, exaggerations, self corrections, and analysis.

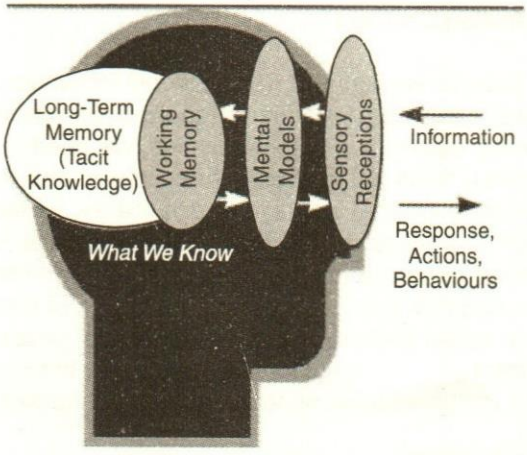


Fig. 4. Cognition, Internalizing and Responding

(e) Social network enablement: This ensures the role of organisational culture in connectivity and collaboration for sharing and learning. The cognitive, emotional, spiritual and physical domains of knowledge interact in many ways to capture and interconnect to build knowledge.

KM systems are mostly focusing on data gathering, storing and retrieving through controlled process, and in a few cases, providing "connected information" or patterns, as an enforced process discipline. Pre-conceived structures or patterns of knowledge, however, interfere with new knowledge. Most of this is static information with limited applicability in context and time. Many engineering companies still see KM systems for engineering as a means to reduce cost and headcount, re-use intellectual capital and accelerate employee learning. To meet this need they create pre-conceived structures. We have seen above the inadequacy of such solutions. Technology solutions here should aim at creating knowledge behaviour and not just replicate historical processes.

Good examples of such implementations are Ebok (Engineering book of Knowledge) of Daimler Chrysler, where knowledge is captured and shared in form of lessons, practices, expertise directories and discussion forums across organisations. Daimler Chrysler's Tech Clubs (community of practices in engineering) are built around robust business processes, capacity for knowledge behaviours and good infrastructure. Specific impact

metrics for the KM system include decrease in time-to-talent, decrease in time to information and increase in innovation.

The Indian Context

This current status of KM in product innovation, poses a great challenge for Indian organisations where, even while we catch up with technologies, we need to set up robust systems and practices to build and also manage the knowledge that we have or acquire, as we innovate, design, manufacture, sell and maintain products. Further, we need to create and nurture a networked knowledge environment within our organisation. Some of these border on social and psychological aspects of people management and people behaviour, especially in the context of the Indian socio-economic and cultural background.

Even in the context of IT Enabled Services, which are growing in India, you need to create knowledge-based relationships across organisations and expertise levels to collectively gain from this Networked Knowledge and cultural tuning.

Limitations and Pitfalls

Finally let us review a few limitations in applicability and pitfalls in implementation. Most KM systems focus on inward-looking knowledge *content creation* (captured knowledge 'objects'), and play least or no attention to cognitive phenomenon and social behaviour of connectivity in the organisational community. Most IT solution providers try to reduce KM to a mechanical exercise of breaking what we know down into discrete 'objects'. And put them through a process. Such an approach is incompatible to how we share knowledge and learn.

These are best described by A Lambe in his book The Autism of Knowledge Management, in which he explodes the myths of KM:-

1. The Myth of Reusability - that knowledge taken from one context can be readily re-used in another
2. The Myth of Universality - that knowledge objects are relevant in all places and times
3. The Myth of Interchangeability - that pieces of knowledge can be transplanted like computer code into other projects and applications
4. The Myth of Completeness - that knowledge has value in the absence of a complete understanding of how it was used
5. The Myth of Liberation - that knowledge will decentralise power and authority in organisations, allowing everyone to do what s/he does best
6. (Added by me) The myth of knowledge permanence.

We live as an integrated experience, we see, know, function in connections. Actions in life are not isolated activities, but are a rich, interconnected part of what we are and what constitutes internalised Knowledge. In other words, we live an integrated experience. Organisations should think of return on experience and not just return on investments.

If we recognize this, then organisations require to foster, nurture and connect, to benefit from KM systems. Therefore one has to shift the focus of KM systems from "Collect Content" and to "Context, Connect, Canvass, Synthesize and Apply".

Product lifecycle management solutions address content management and information delivery for engineers. It is also important to ensure currency of content/ information. This process is critical to manage knowledge growth and function in a diminishing half lifecycle of knowledge environment.

When we thread product lifecycle solutions to a KM system, organisations can also be productive and innovative in everything they do. As we gain our experience, we also change our perceptions, values, decisions etc.

We tend to see today's problems through yesterdays solutions. As a next step, we seek solutions for today's problems as an extrapolation of yesterday's solutions. Unfortunately the context of knowledge changes and therefore the solution does not work. In this sense all knowledge is challenged during its lifecycle. In an innovative environment one must revisit current knowledge when a knowledge object hits half life-cycle, and perhaps discard it before it becomes a burden. In this sense KM systems should always be like "work in progress and progress in multiple evolutionary paths". When you have such they bring in transformational innovation.

To avoid intellectual atrophy, Research and Development in organisations should recognise this half lifecycle and work in the earlier half of this cycle to be productive. Unfortunately the half lifecycle period of knowledge is also continuously decreasing, challenging the R&D engineers to be more intensive in their work and therefore come up with more innovation than in the past. In progressive companies like Siemens, 75% of their products are less than five years old.

True Knowledge Management systems are not intended to fill minds or databases but to open minds to work together. Even "Management strategies need to shift from command and control to sense and respond."

Conclusion

The golden thread of product lifecycle, well woven into a Knowledge Management system, provides not only a productivity enhancer but also an innovative environment for engineering organisations. Such a Knowledge Management systems should be tailored for each organisation, keeping in mind the products they make, the values (amongst people), the organisation works on, and culture or environment the organisation operates in. In the Indian context, we have all the enabling technologies available. However, one has to be sensitive to the approach to be taken, the expectations to be set and metrics to monitor. "Knowledge is like money: to be of value it must circulate, and in circulating it can increase in quantity and hopefully, value" (Louis L'Amour).

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The library is not a shrine for the worship of books. It is not a temple where literary incense must be burned or where one's devotion to the bound book is expressed in ritual. A library, to modify the famous metaphor of Socrates, should be the delivery room for the birth of ideas—a place where history comes to life.

– Norman Cousins

Relevance of Knowledge Management at Power System Operation Control Centres in India

Vivek Pandey & K. Momaya

Socio-technical systems are complex. They comprise of several sub-systems with interrelationships that mutually influence each other's performance. The Indian power system is one such system. This paper dwells on the issues related to knowledge management and its relevance to the performance of system operators at Power System Control Centres.

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A system is defined as an integrated set of components with an identifiable boundary working together for some purpose. Every system has a boundary, inputs, outputs, sub-systems and interfaces. The functional characteristics of a 'system' is determined by the 'intent of the design', the 'characteristics of its components', the 'interrelationships existing between them', the 'environment' in which it is operating and the 'constraints'. The behaviour of the various sub-systems is inevitably influenced by the behaviour of the other sub-systems. A system can be decomposed into its sub-systems or component parts for the purpose of design, implementation, analysis, and maintenance. But during the functional stage each part of the system performs as an integrated whole. Therefore any new element that has to be installed has to be compatible and aligned with the rest of the system to be worthwhile.

System states

In the course of operation a system may dynamically pass through different states - '*normal*', '*alert*', '*emergency*', '*in-extremis*' and '*restorative*'. [Fink & Carlsen, 1978, 'State Transition Diagram', (IEEE Spectrum 1978].

All these states except the 'normal' state are 'abnormal' and are undesirable. Therefore the system should be kept within the normal band for the maximum duration. A 'perfect', 'well-designed' and 'well-maintained' system has inbuilt automatic control systems, feedback loops, and security mechanism that are capable of realising that objective. However creating such utopian systems with reliability of 100% would neither be technically feasible nor economically viable for society. In a realistic scenario, the stakeholders relax their specifications and bargain for a system that has 'less than perfect' reliability and

performance. We might term these systems as realistic systems for the purpose of our discussion. In a realistic system the efforts are directed to achieve acceptable reliability, efficiency and performance under the supervision of a system operator. The system operator is usually provided with the data of regarding the performance of the system at any given time to help him diagnose the system state. At times he might be provided with intelligent decision support systems to assist him in performing his designated role.

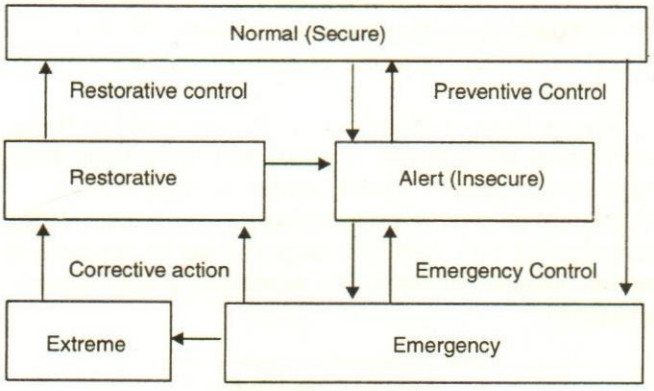

Fig. 1. State transition diagram

Role of a system operator

The realistic system may migrate from 'normal' to 'abnormal' state on account of perturbations internal to the system or external to the system. Usually the inbuilt control system is capable of automatically maintaining system stability during normal as well as abnormal states. However at times the control system may fail or malfunction, causing the system to migrate into an unsafe zone rather quickly. At this stage the system operator who is closely supervising the system must quickly sense the change in system behaviour (what is happening?), identify the underlying causes (why it is happening?), anticipate the future state (what might happen?) and make necessary interventions to prevent degeneration. This is generally termed as '*situational awareness*' and is defined as a mental model of our operating environment and our place in it. It often consists of four processes including perception, comprehension, projection, and prediction [*Loughgran and Stahl, November 2000, 'Gaming and Shared Situation Awareness'*].

Needless to mention, the system operator has a huge responsibility in a system, as he becomes an inseparable part of the system itself. System operator is expected to analyse ambiguous situations with no pre-programmed instructions or rules. His performance becomes a vital variable in the performance of the system espe-

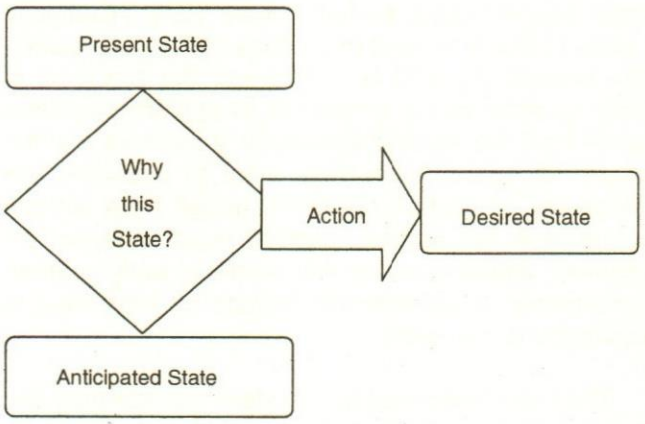

Fig. 2. System Operator intervention

cially in online systems. His '*action scripts*' (interventions) in the system would be based on the '*mental simulations*' and '*mental models*' [Gary Klein 2003, '*Recognition-Primed Decision Model*'].

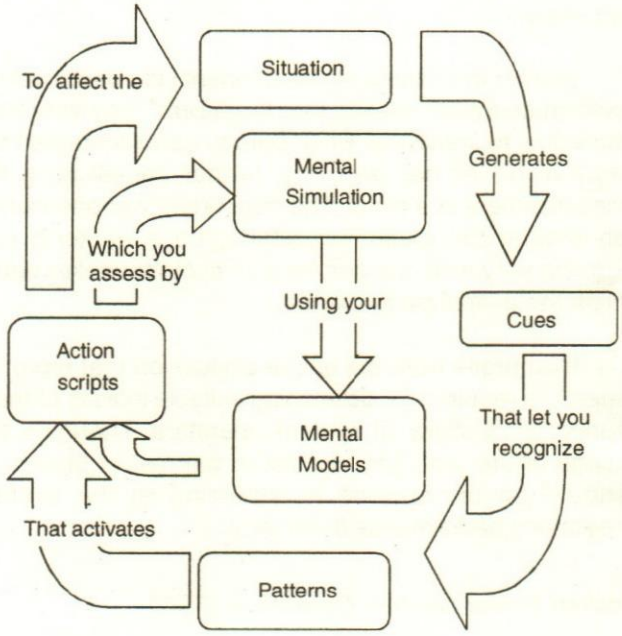

Fig. 3. Recognition-primed Decision Model

[Adapted from Recognition-Primed Decision Model in Gary Klein's, Intuition At Work, Currency Books, 2003]

The system operator's job is thus in the domain of knowledge work

Productivity of System Operators

Concept of productivity for the system operators poses several challenges. One basic way of defining

productivity is "output divided by input" (O/I). If Company X uses 100 units of input to produce 100 units of output, their productivity ratio is 1. However the problems in applying productivity measures to system operation results from the intrinsic complexity of the work and the general disagreements about what to evaluate. The complexity of system operation arises from several factors. It is not routine, involves much independent judgment, and requires several people to work together. Furthermore, a considerable amount of knowledge is required to do the work.

The tasks performed by a system operator inter alia involve collecting information (supervising the system), executing control actions, contingency analysis (what if scenarios), problem solving and decision-making. The impact of their actions is reflected in operating variables of the system, which are intangible in nature. The non-routine nature of the job means that it is very difficult to measure a norm. There is no obvious average to observe and record, so any measure will be somewhat inaccurate.

Further the degree of independent judgment involved system operation means that the "norm" may vary from individual to individual. Each person can accomplish the work in his or her own way, further complicating the measurement of a norm. The dependency of one worker on another can mean that, although one worker is performing very well, the problems of another worker determine the overall performance.

It emerges from the above discussion that more research is required for developing suitable indices of measuring productivity of system operators. Therefore the usage of the term 'productivity' in the rest of the article should be understood as referring to the system operator's performance in general.

Indian Power System Operation (PSO)

The frameworks discussed in the preceding paragraphs are applicable to the Indian power system as well. Indian power system comprises of hundreds of generating stations based on different technologies, which are coupled together with the help of a vast transmission system. Each of these components is owned by a different utility. The consumers, whether they are industrial, commercial, agricultural, domestic or government establishment, are hooked to this network at different nodes for consuming this product which is delivered to them within milliseconds of being generated. For the stability and reliability of the integrated system, supply must continually match the demand, even though they are temporal and stochastically varying. Various components of this system interact with each other in a dynamic fashion. Ensuring reliable, efficient and economic operation of this machine involves extensive off-line as well as real-time coordination between thousands of personnel affiliated to different utilities involved in the chain. Even a seemingly innocuous human error or a technical snag has the potential to pull down the entire power system within seconds resulting in a blackout that has huge social, economic and political implications. This vulnerability makes power system operation a *'mission critical'* activity and the system operator an indispensable entity.

Power System Operation (PSO) in India is being coordinated through five regional and more than thirty state control centres. These control centres are owned by different utilities and they collaborate with each other for executing their statutory responsibility of ensuring a secure, reliable, efficient and economic power system operation.

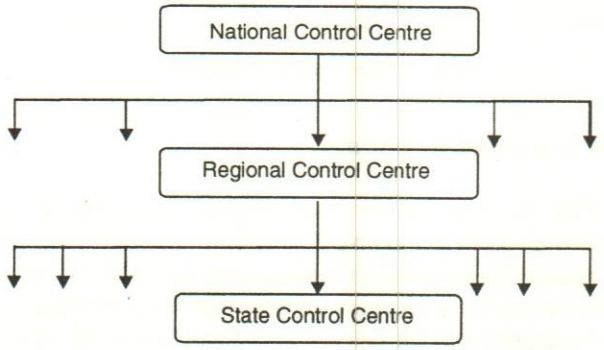

Fig. 4. PSO control centres in India

Relevance of KM in PSO

The power system is a socio-technical system. Its success depends on the success of its design, performance of its subsystems, their inter-relationships and the performance of the system operator. The coordination services offered by the power system operators are unique and mission critical. While the performance of the subsystems could be improved by requisite investments in technology and other infrastructure, the performance of the power system operators would be a function of their domain knowledge, problem solving skills and motivation to deliver. Unlike the commercial organizations competition in power system operation is not against any other organization but against the randomly occurring combination of expected and unexpected events trying to destabilize the power delivery infrastructure. Given the limited time available for

responding to emergency situations what would come to his rescue would be his experience, values, insight and grounded intuition.

A model of human performance at control centres as discussed in the report by CIGRE working group 39.03 indicates that there are numerous individuals and environmental factors that contribute to job performance. The operator's skills and knowledge (the fact that they know 'how to perform') is clearly an important factor in the quality of operating performance. The report also mentions that detailed symptom-based procedures ("If this is observed, do that...") have only limited applicability in system operation because of the complexity of power systems and the impossibility of anticipating every event.

PSO falls under the realm of essential public service and is presently being carried out within the government set up and under regulatory oversight. The activities have to be limited within a code of discipline and commercial rules specified by the regulators. A diverse constituency has a stake in power system operation. This includes generating utilities, transmission utilities, distribution companies, consumers, manufacturers, market intermediaries, academic institutions, technologists, economists, lending agencies, planners, administrators, government authorities, regulatory bodies, legislature, judiciary and many others. Decisions have to evolve after a considerable formal and informal interaction among stakeholders and system operators are subject to heightened value-laden expectations for neutrality, fairness, transparency and accountability. This makes power system operation multidisciplinary in nature and calls for an understanding of all related areas apart from the technical aspects. Considering the diversity of expertise required a control centre, expecting a single individual to have proficiency in every area would be unrealistic. Therefore pooling of expertise and effective knowledge management appear to be the most practical alternative to achieve the desired objective.

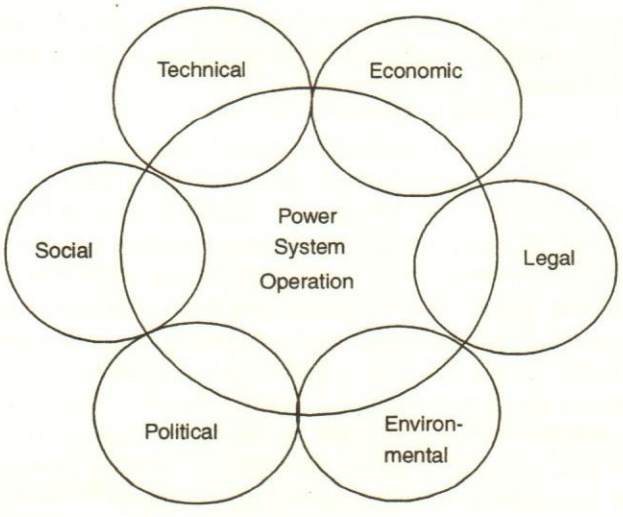

Fig. 5. Multidisciplinary aspects of PSO

KM practices presently adopted in PSO

All organizations overseeing PSO in India are awash with 'represented' and 'tacit knowledge' but much of that knowledge is not even visible since other members of the organization, or customers of the company are not even aware of its existence. Knowledge transfer takes place primary through sporadic personal interactions, meetings and conferences. Officials from the administrative strata generally attend gatherings. Formal training programmes are few and far between. Most of these programmes are organized in metros and considered to be more an occasion to relax than an opportunity to learn and share. Pressure to economize on employee cost in a tight regulatory regime has resulted in downsizing and a corresponding slowdown in fresh recruitments. This has made the matter worse because those who are nominated in the training programmes are either those who can be easily spared or those who manage to get themselves nominated for other reasons.

The control centres at the regional as well as state level operate round the clock with the help of a small team of system operators. Apart from the occupational stress, the job involves immense physiological stress arising from frequent disruption of natural circadian rhythms and exclusion from daily business activities. All this also has a bearing on the performance of system operators. Unlike in 24x7 customer care service centres, the absence of a critical mass in terms of number of personnel in one control centre makes it slightly difficult for the management to address the physiological problem.

The output of control centre operations is highly intangible. The organizations consider it a low priority area. Incentives for enhancing performance are difficult to design. The control centres have to be run within a given framework of administrative processes with elaborate internal rules and reporting systems. The rewards and status of the system operator position in India is generally considered to be incommensurate with their level of responsibility. Further there is a general lack of awareness about the importance of system operation in the power sector. Liberalization has opened a large number of avenues for job-seeking youngsters and the number of talented engineers willing to serve in this area is gradually diminishing.

The problem is particularly acute in state level control centres. Employees past their prime age are posted in the control centres. These personnel neither have the motivation in acquiring the skill nor adequate time to comprehend the nuances of system operation. Process of hiring, firing, disciplining and financially rewarding employees are highly constrained.

The situation at the regional control centres is slightly better. They have greater exposure and better mechanisms of knowledge acquisition and sharing. However the rapidly changing environment in India and particularly in the power sector has made the situation difficult even for them. Time available for thinking and acquiring new knowledge vital for achieving the strategic objectives has shrunk drastically. The increased mobility of the workforce in general and retirements has also led to diminishing knowledge reserves.

In the ongoing reforms in India the focus has once again shifted to the infrastructure sector such as transport, telecom and power. At the regional level conscious efforts are being made to enhance the productivity and performance of control centres. Debriefing sessions are conducted after major contingencies to analyse the event and identify deficiencies. Focussed programmes are being conducted to revitalize the theoretical concepts with the help of academic institutions. Need-based short training modules on different focus areas are organized. Operators from the state level are also invited to take part in these sessions. Libraries are being gradually upgraded with relevant publications. Reading habits of individuals are being improved by encouraging them to take specific research areas and make short presentations. This is also helping them in polishing their public speaking skills. Employees of all levels and all departments attend these group talks to enable cross-fertilization ideas. Knowledge creation through systematic documentation of operator experience in the form of papers is being encouraged. Seminars, workshops, conferences and exhibitions are being organized to provide an opportunity to operators to share and enlarge domain knowledge. Internet access has been provided to every executive to enable them to take advantage of the information available online. Web-groups with different focus areas have been formed to facilitate interaction between operators posted at different control centres. Major issues are debated through videoconferences.

The new recruits are groomed with the help of classroom training; on-the job training and industrial visits. Junior executives are included in the team from the control centres that meet stakeholders at regular intervals.

Fig. 6. Present KM initiatives in Regional PSO

Suggestions

The knowledge management (KM) initiatives presently being pursued are steps in the right direction for capability building in PSO. However, the participation in these initiatives is still lukewarm mainly on account of cultural prejudices and a natural resistance to change. These could be addressed through suitable interventions. Individual counselling and behavioural workshops could be found useful in tackling personality and culture related issues. Special attention needs to be given for improving reading and communication skills.

On the KM front more focussed initiatives on the lines of SECI model of socialization; externalisation, combination and internalisation could also be considered. Standard KM techniques such as knowledge portals and mentoring techniques could be also explored. Electronic performance support systems (EPSS), embedded hypertext based helps, multimedia or other technologies could be extensively deployed.

Organizations performing system operation function would have to move beyond narrow interests and create shared infrastructure for training, capability building, R&D and KM. Effective networking between system operators in different control centres through formal and informal channels would help in developing trust and technical solidarity. This would also help in nurturing the profession in India. Efforts are also required towards developing a metrics for measuring the impact of KM initiatives. Capability Maturity Models similar to those used in software industry could be developed in PSO to assess the gap between the present and desired maturity level.

Concluding Remarks

Running a complex system is very challenging and is very much a question of playing against the odds. There is a lot to be gained by stacking odds in your favour. Being aware of what is going on and then making the most opportune time can make

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Concluding Remarks

Running a complex system is very challenging and is very much a question of playing against the odds. There is a lot to be gained by stacking odds in your favour. Being aware of what is going on and then making the right intervention at the most opportune time can make the difference between survival and profitability, or failure and loss. Effective knowledge management policies would not guarantee success or survival. They simply improve the odds in favour of the system operator. KM initiatives could help in integrating various efforts in the direction of enhancing the performance of system operators. Cooperation from internal as well as external stakeholders would be essential in realising the collective vision of a near perfect power system.

Productivity of knowledge activities is key to competitiveness and success. Sound implementation of KM can improve competitiveness on some key factors. It demands sound strategy implementation on wise choices. Strategic choices on implementation approaches will play a critical role in leveraging KM for competitiveness (Ganeshraj and Momaya, 2006). Organizations in India need to move much beyond technology, often IT-centric approaches of KM to people/culture-centric KM approaches, where knowledge creation and use becomes a joyful way of life.

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Information is the manager's main tool, indeed the managers 'capital,' and it is he who must decide what information he needs and how to use it.

– Peter F. Drucker

Factors of Information Systems Outsourcing Decisions: A Review

Umesh Gulla & M.P. Gupta

Information Systems outsourcing is being explored worldwide to address various Information Systems (IS) management problems faced by companies. How to initiate and execute the IS outsourcing process is at a nascent stage. This paper reviews some of the factors that a framework would entail for guiding the IS practitioners to undertake IS outsourcing systematically, considering the gains as well as the likely risks.

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Information Technology is increasingly being deployed to improve productivity and quality in business organizations. However the complexities of Information Technology puts these organizations under pressure to keep up with the pace of technology solutions. It is leading to undermining the focus on the core business activity for the business organizations. In answer to this dilemma, information systems outsourcing is today emerging as a smart option for organizations that need to focus on their core business areas and yet leverage the power of information technology.

The strategic, operational and technology advantages that outsourcing can bring to business organizations cannot be ignored. Managers are faced with the question: should companies constantly invest in skills and time for creating a desired information system environment? Or should they instead use their limited resources for their core competencies? If the recent outsourcing decisions are any indicators, it seem managers have opted for the outsourcing route to maintain the focus on their core business while delegating IS related functions to the outsourcing vendors. Further, the trend towards IS outsourcing is global as reported by media and research papers in recent times.

Key Issues in Information System Outsourcing

While some proponents have talked of benefits of outsourcing in the form of lower costs, focus on core business, keeping up with IS upgradation, there have been a large number of unresolved issues for outsourcing in the form of higher risks, lack/loss of innovation, poor understanding about business practices, security of data, etc (Earl, 1996; Khalfan, 2004; Palvia, 1995). There appears to be an inevitable trend as companies are increasingly viewing Information Systems merely as a tool for enabling and supporting core business activities without understanding the complex and integral relationship of

Table 1: Brief of Few Important IS Outsourcing Frameworks

Author	Main Features of the Framework	Limitations of the Framework
Willcock et.al. (2000)	Framework considering the factors primarily internal to the organization as level of in-house IT expertise, the degree of business uncertainty reflected through changing requirements, the degree of systems interconnectedness and complexity, the role of IT as a business differentiator, and the relationship between IT and corporate strategy.	Framework does not lay sufficient weight to the external environmental factors.
McIvor (2000)	Proposed an outsourcing framework having four-stage analysis-Defining core activities; Evaluate value chain activities; Cost analysis; and finally Relationship analysis.	Framework is generalastic in nature and talks of stages only in the outsourcing process.
King and Malhotra (2000)	The framework is based on making a comparative assessment of the strengths and limitations of IS outsourcing and of the internal markets approach in terms of operational, tactical, and strategic impacts of the choice among the alternatives.	Framework is inclined towards the internal market approach by comparing external bids with internal costs which may be difficult to compare. Besides, it banks heavily on post-decision impact.
Kern et.al.,(2002)	Explored the ASP route to acquire the IS services with distinct advantages but also highlighted a set of risks	The framework simply suggests ASP as one option for IS sourcing without providing the factors, internal as well as external, that should be considered by the managers while deciding upon this option.
Smith et.al,(1996)	Outsourcing decisions may be evaluated on three factors namely environment of the organization, resources available within the organization and project management approach.	This framework has been suggested primarily for off-shore software development and maintenance and hence is relevant in specific situations only.
Kern and Willcocks (2000)	The framework considered the core dimensions of the relationship with the vendors as context, contract, structure, interactions and behavior in an outsourcing arrangement.	This model guides post-outsourcing decision making and does not answer why outsourcing should be undertaken.
Udo (2000)	The framework suggested the analytical hierarchy process (AHP) as a potential tool for analyzing information technology outsourcing decisions to handle complex, multicriteria, qualitative decision variables involved in the IS outsourcing decision-making process.	The framework's complexities makes it difficult for many of the practitioners to use it, including identifying the possible decision factors.
Lacity et.al.,(1996)	Developed a set of frameworks to clarify sourcing options and aid managers in deciding which IS functions to contract and which to retain in-house.	The set of frameworks have limited scope and are applicable to particular decision situations only in outsourcing situations.
Lee and Kim (1997)	The model analyzed IS outsourcing practices followed in Korean conglomerate groups wherein IS functions are outsourced primarily by default to affiliate companies.	This model is suitable for captive sourcing of information systems and is constrained by not considering other outsourcing options.

IS with these business processes (DiRomuldo & Gurbaxani, 1998; Kern & Willcocks, 2000; McFarlan & Nolan, 1995). While a successful IS outsourcing relationship can help the customer to achieve major benefits such as cost-savings, increased flexibility, better quality of services and access to new technology, a failed outsourcing arrangement may turn out to be very costly to the outsourcing customer in terms of higher than expected outsourcing bills, loss of control over quality and level of services, compromised information security and poor staff morale. The potential dangers are particularly acute for long-term outsourcing contracts. While there are success stories like Xerox, there are also cases of failure in outsourcing IS decisions. Outsourcing decisions are rarely taken within a thoroughly strategic perspective with many companies adopting a short-term perspective and being motivated primarily by the search for short-term cost reductions. It is very important that IS managers carry out IS outsourcing decisions from a strategic perspective and integrate the IS outsourcing strategy into the overall business strategy of the organization.

Need for an IS Outsourcing Framework

When deciding on outsourcing, companies should proceed with caution and should be clear on why they are outsourcing, and what they are going to get from outsourcing. However, companies are not reported to follow caution in outsourcing decisions. In a survey undertaken by Lonsdale and Cox (1997), only 20 percent of organizations were outsourcing in a sophisticated manner. Others were simply following the latest fad. In spite

of the criticality of the nature of IS outsourcing decisions it still remains in the nascent stage in terms of how to initiate and execute the IS outsourcing process. IS managers need to make a roadmap for IS outsourcing that is suitable to their organization. Hence it is desired to formulate an IS outsourcing framework that guides managers to identify and analyze the need for outsourcing keeping in view the technology as well as management factors - internal as well as external to the organization. The framework should be designed to guide the IS practitioners to undertake IS outsource systematically considering the gains as well as the likely risks due to outsourcing, so as to account for them in the outsourcing structure. Further the framework should be simple to understand and use; and yet be flexible and exhaustive to cover all the influencing factors in IS outsourcing decisions.

Existing Frameworks and their Limitations

Literature survey reveals that there have been a few attempts to provide some methods to guide the outsourcing process. However these have certain limitations from the perspective of the practicing manager. Quinn and Hilmer (1994) have identified issues such as costs, core and peripheral activities, supplier relationships and technologies which should be considered in any outsourcing decision without proposing a framework that would guide the outsourcing process. McFarlan and Nolan (1995) suggested a strategic grid for information resource management considering the company's dependence on information on one axis, while on the other axis the importance of sustained, innovative information resource development is measured. Based upon the position of the IS function on this grid, managers may decide to outsource such functions. The framework has limited relevance as it considers only two parameters, which are criticality of information systems and dependence on information systems, on which outsourcing is evaluated. Fink (1994) and Sherwood (1997) have suggested an organizational model for IS outsourcing. However, both of these frameworks consider only the security aspects of outsourcing, reducing their relevance for its application. Table 1 gives the brief of some of the IS outsourcing frameworks suggested by various authors and also lists major limitations of these frameworks.

Hence it is prudent to formulate an IS outsourcing framework that guides managers to identify and analyze the need for outsourcing keeping in view the technology as well as management factors - internal as well as external to the organization. The framework should be designed to guide the IS practitioners to undertake IS outsource systematically considering the gains as well as the likely risks due to outsourcing so as to account for them in the outsourcing structure. For practicing managers it is simple to understand and use and yet is flexible and exhaustive to cover all the influencing factors IS outsourcing decisions.

A Review of Factors of IS Outsourcing Framework

A framework is concerned with making recommendations of what to do, when and how to do, and contains prescriptive elements as it suggests that IS managers should carry out the outsourcing process in a certain defined way. A proposal entailing some of the important factors and their interplay is presented in Fig. 1. This emphasizes upon creating a strategic IS alignment between the business strategy and information systems strategy, and accordingly evolves a suitable information systems outsourcing structure. The degree to which the organization would outsource would be decided by considering the outsourcing drivers and the outsourcing barriers in that particular organization where IS outsourcing is planned. Further the impact of outsourcing on the strategic interests of the business organization as well as its effect on the routine operations of the organization should be identified and measured. This IS outsourcing framework consists of a series of logically sequential stages that guide the managers in outsourcing decisions. The brief description of these factors is provided below.

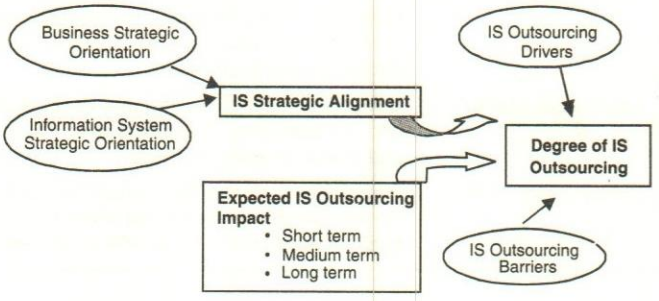

Fig. 1. Framework for IS Outsourcing

Business Strategic Orientation

Today's organizations survive and compete based upon their competitive strengths. Companies need to identify their core competence skills and formulate their products and services around these skills in order to differentiate from the competitors by offering better products and services at lower costs/inputs. Further it is important that companies also foresee, identify and build newer competencies that would keep them ahead of competition as well as maintain the current position. Some of the major factors that represent business strategic orientation for outsourcing decisions are mentioned below:

- *Business Focus:* Companies need to identify the core focus in their business conditions and correspondingly identify the skills required to cater to core focus area of business operations. Further skills may be categorized in two sets-core competencies and auxiliary skills. It is advised to build upon the core competence skills and outsource to acquire the auxiliary skills.
- *Learning Competencies:* Companies need to keep track of changes in customer requirements and market trends and accordingly build skills for future requirements. This requires the companies to maintain a conducive working environment that facilitates learning on a continuous basis in order to upgrade skills and acquire newer skills.
- *Devising, Measuring and Monitoring Performance metrics spanning over Short, Medium and Long-term:* With outsourcing approaches, the structure and job descriptions change and hence companies should invest in devising new metrics for measuring new performance parameters and measure these in terms of its effects in short, medium and long-term.
- *Change management:* Outsourcing leads to structural changes and hence companies should build strategies for managing change smoothly and implement the new structure.

Information Systems Strategic Orientation

Information technology is an integral part of business architecture, and infact it drives businesses in the current business environment. However right technology is an outcome of appropriate IS strategy. Information technology tools have increasingly become complex, costly and there are various options available leading to confusion in many IS-related decision situations. Technology life cycle for IS solutions have shrunk considerably leading to high rate of obsolescence of IS solutions. Further unavailability of skilled manpower and difficulties in upgrading the skills of the existing IT employees in the IT domain have become serious concerns for most of the organizations. Thus the companies have to look for an IT structure that utilizes the investments for the existing users and also provides additional uses for the optimal utilization of its IT assets. IS Outsourcing has emerged as an effective solution in such a scenario. The factors that represent IS strategic orientation are:

- Selection of Technology and IT tools
- Procurement of IS solutions
- Implementation of IS solutions
- Aligning Information technology tools with the business proceses
- IS performance metrics
- Hiring and Retaining effective and skilled IT manpower
- Upgrading continuously the technical skill sets to prepare for future requirements
- *Control over IS setup (operational as well as strategic control)*

Information Systems Strategic Alignment

There is a very thin line between the business and information technology in today's business environment. Information technology drives businesses by way of enabling and facilitating processes through the use of powerful IT tools. Hence information technology itself becomes an important part of business strategy. IS policy in any business organization is the outcome of the strategic business orientation and strategic orientation of its information systems. Strategic Alignment of business strategy and IS strategy may result in a structure where synergies between the organization's internal capabilities and the external vendor's strengths are created. For example, a company may outsource a variety of IT functions, ranging from PC maintenance to network management, data center management, and retain the role in system design. Depending upon the level of skills required in the area of information systems which constitute of knowledge in functional domain as well as knowledge of information technology, IT functions may be categorized into three levels:

Level 1 **System Design**

Level 2 **System Development**

Level 3 **System Maintenance**

System design activities usually consist of the requirements of the company in its business environment and are guided by the processes of the company. As the reliance of business process on information systems have increased due to extensive use of IT tools, the divide between the management skills and IT has thinned out. Such functions are strategic in nature and it may not be advisable to outsource totally such function (Fig. 2). A company should have high control in deciding the structure of the system and only those activities that implement the system design capabilities should be outsourced.

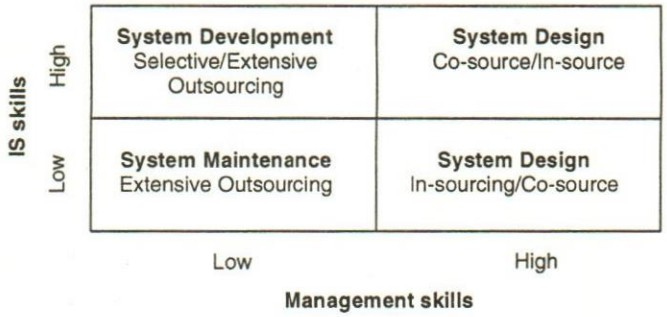

Fig. 2. Information System Functions

The company, depending upon the extent of IT skills available inhouse and other factors such as security of the information, may accordingly decide to outsource IT function as the system development and system maintenance activities through selective or extensive out-sourcing. An effective IS system is the outcome of a visionary and yet practical business strategy and the IS strategy. Blending the business strategy with IS strategy leads to the strategic alignment of the information systems and provides a roadmap to the organization. This is an iterative process and is performed till an optimum level is arrived at. The factors that constitute IS alignment are:

- *Management of IS capabilities* which would be a combination of the capabilities that are generated in-house and the capabilities that are procured through the outsourcing relationship.
- *Extent of IT penetration:* While IT facilitates business processes, over use of IT may not give optimum benefits. Thus managers need to identify the extent of IT usage in their concerns that would yield optimum results.
- *Core competence skills* are identified along with the auxiliary skills. These are developed and maintained keeping in view the market requirements.
- *Project management* capabilities for different stages of software project management in system analysis, system design, development implementation, and system maintenance in the outsourcing relationship environment.
- *Vendor management for outsourcing:* Strong vendor management skills are desired for developing the strategic relationships with outsourcing partners and effective implementation of outsourcing process.

The following Table 2 provides a list questions that helps give clarity on IS alignment in a bank and a similar approach may be taken for any company in any industry:

Expected Impact of IS Outsourcing

Outsourcing has a direct impact on the way in which a company manages its short-term as well as long-term resources. Various authors have described in some details about the benefits as well as disadvantages of IS outsourcing. Martinsons (1993) has listed cost savings, technology acquisition and improved flexibility for dynamic business environments, as the likely benefits and risks of over reliance on IT vendors and loss of strategic flexibility as the potential disadvantages. Others have listed the risks which range from incomplete contracting, lack of maturity and experience on par of company and vendor (Willcocks et al, 1995), loss of innovative capabilities and technological indivisibility (Earl, 1996), intangible costs of outsourcing, technological captivity to vendor etc (Palvia, 1995). Thus it becomes very important to consider the impact of outsourcing considering not only the benefits that would be roped in by the vendor but it should also include all the likely risks associated with the outsourcing relationship. Impact of outsourcing may be divided into three categories depending upon the time period as short term impact, mid-term impact and long term impact. Apart from many other factors, the expected impact of outsourcing will finally govern the degree of outsourcing to be undertaken. Expected impact of outsourcing may be divided into three categories depending upon the time period as short-term impact, mid-term impact and long-term impact.

- ***Short-term Impact:*** This category would include the effects of outsourcing which are usually felt in six months to one year from the start of outsourcing. These may be concerning the IS efficiency, service levels of the IS operations, cost savings on IS and productivity improvements.
- ***Medium-term Impact:*** This impact would result over a time span of one to three years from the initiation of outsourcing. It usually deals with the tactical business concerning the profitability, change in overall performance levels of whole systems and processes, IS controls and experiences with the outsourcing vendor including the associated risks of outsourcing.
- ***Long-term Impact:*** Long-term impact of outsourcing would be felt usually after three years and onwards and deals with subjects usually strategic to the company. It would consist of the changes in the organization culture, impact of

Table 2: Constituents of IS Alignment

(I) Business Strategic Orientation (a) Bank keeps track of its customers' changing requirements, offerings from competing banks and reviews its services on regular intervals. (b) Managing money is the core business of bank. (c) Bank uses technology extensively to cut cost of handling customer transactions. (d) Bank plans for branch expansion, introducing new products and services, process innovation at regular intervals.	**IS Strategic Alignment** (a) Bank uses IS tools extensively in banking transactions in customer dealing, marketing and selling products & services, customer relationship, treasury, financial analysis etc. (b) IT is considered as an integral tool in bank's planning and strategies. (c) Bank has special incentives (monetary and non-monetary) to attract and retain skilled IT employees. (d) Bank has strategic alliance/subsidiary company (or has plans in near future) to sell the specialized IT-enabled services to other banks and companies. (e) Service level Agreements (SLAs) of IS services are met by IS vendors. (f) Business Process Re-engineering and process improvements supplemented with IT tools have been successfully undertaken.
(II) IS Strategic Orientation (a) Bank has developed sophisticated IS tools in-house for banking processes. (b) Bank is able to attract and retain skilled IT manpower. (c) The bank has been able to maintain and upgrade the IS infrastructure according to the changing requirements. (d) Regular trainings are imparted to IS employees to keep up with the new skills. (e) Bank has a structured procurement policy and procedure for buying IS products and services and managing the IS vendors.	

the new organization structure after outsourcing, increase/decrease in core strengths of the company and development of new skills and competencies by the company.

Table 3 provides a list questions that helps clarity on expected impact of outsourcing.

Degree of IS Outsourcing

Deciding the degree of IS outsourcing and an ownership pattern of the IT infrastructure is a crucial decision for managers. The above framework helps the manager to decide on the degree of Information Systems outsourcing that a company may choose in order to

as the case wherein the organization spends more than 80% of its IT budget towards the outsourcing vendor (Lacity et. al., 1996).

2. **Total Insourcing:** Refers to the sourcing option in which the organization owns the IT infrastructure and is responsible to provide the services to its users. The organization has all the employees who are responsible to provide IS services on its payroll. There is very little involvement of external party. The employees of the organization are involved in most of the activities starting from the system design to system development and maintenance stages.

3. **Selective Outsourcing:** Provides for a IS setup in which organization has overall control of IT infrastructure and is responsible for the service

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Degree of IS Outsourcing

Deciding the degree of IS outsourcing and an ownership pattern of the IT infrastructure is a crucial decision for managers. The above framework helps the manager to decide on the degree of Information Systems Outsourcing that a company may choose in order to achieve the expected impact. A company can choose a varying degree of involvement of IT vendor in the outsourcing relationship. Depending upon the various parameters of ownership as title of the assets, proportion of IT budget spent on outsourcing vendor or any other parameter, different sourcing options may be:

1. **Total Outsourcing:** In this sourcing option the organization has a very low amount of ownership of IT assets. However the outsourcing vendor commits an agreed level of IS service to the customer. Hence in this, the organization owns the IS service without bothering about the nuts and bolts of the IS infrastructure that produce the IS service. The total outsourcing is defined as the case wherein the organization spends more than 80% of its IT budget towards the outsourcing vendor (Lacity et. al., 1996).

2. **Total Insourcing:** Refers to the sourcing option in which the organization owns the IT infrastructure and is responsible to provide the services to its users. The organization has all the employees who are responsible to provide IS services on its payroll. There is very little involvement of external party. The employees of the organization are involved in most of the activities starting from the system design to system development and maintenance stages.

3. **Selective Outsourcing:** Provides for a IS setup in which organization has overall control of IT infrastructure and is responsible for the service deliverables to its user for IS services. However the organization would contract out some IS activities to external vendors that would produce the defined deliverables corresponding to that specific IS activity. In such cases vendors complement the organization's information systems capabilities.

Degree to which an organization outsources its IT functions have important implications for the organization. Hence any organization that wishes to focus on developing the core competence on understanding the customer requirements and satisfying the profitably,

Table 3: Impact Assessment of IS Outsourcing

IS Outsourcing Impact (Short-Term)	IS Outsourcing Impact (Medium-Term)	IS Outsourcing Impact (Long-Term)
(a) Company has experienced satisfactory uptime of Information Systems used in its operations.	(a) Customer satisfaction index scores have shown satisfactory positive growth over last year.	(a) Company monitors and upgrades its core skills and strengths with respect to its competitors on continuous basis.
(b) Company has experienced improvements in IS driven functions that are outsourced.	(b) IS tools have facilitated managers in planning and improved decision making.	(b) There has been high priority allotted to the development of new skill sets among the employees.
(c) Number of system break-downs are under control.	(c) The Company is facing lower staff turnover in IS department.	(c) Employees of the Company undergo training sessions for upgrading existing skills and new skills on regular intervals.
(d) IS has features which are simple and user-friendly.	(d) IS setup has improved operational performance of employees in terms of number of customers handled, business per employee, profit per employee.	(d) Company uses extensively sophisticated knowledge management tools as Intranet, Video & Audio Conferencing systems etc.
(e) Company provides adequate service availability to customers (e.g. 24 hours service).	(e) The existing IS setup has provided acceptable/optimum financial returns on the investment into IT assets.	(e) Company has been receiving high participation of its employees in suggesting improvements and new business ideas.
(f) Number of errors in transaction processing are under control.	(f) IS setup has facilitated/enabled value additions to the customer offering.	(f) Employees of the Company are open to learning new skills and adjust to new roles.
(g) Outsourcing has resulted in cost reduction in servicing customers.	(g) Company has adequate control to decide the technology to be used in the IS infrastructure in the Company and modifications as per its require-ments.	
(h) There is reduction in costs of training & development in Information Technology related skills.	(h) Company has adequate control over the employees in the IS department.	
(i) Inventory costs of IT spares have decreased.	(i) Company exercises adequate control in the system development process and over IT vendors.	
(j) Costs related to employee overheads have decreased.		

would want to go for extensive outsourcing. While high degree of outsourcing rids organizations of the IS complexities, it brings with it certain risks of overdependance on outsourcing vendors, loss of IS expertise, security concerns etc. On the other extreme, low outsourcing leads to situations, where limited resources of the organization are spread over too many areas leading to poor utilization of these resources and finally resulting in low performance levels, outdated products/services, difficulties in sustaining existing market shares etc. In between the two extremes, some managers try to make a trade-off between the gains and risks of outsourcing by following selective outsourcing approach.

IS Outsourcing Drivers

The extent to which a bank shall undertake the outsourcing of its information systems would be guided by various reasons that we have referred to as *Outsourcing drivers*. A particular company may be driven to outsourcing due to different reasons particular to that company like the market segment it is operating in, level of competition, ownership nature of the company, management focus etc. and these *drivers* may be many as business focus on core functions, low cost of ownership, shortage of skilled IT manpower, low setup time, and the like. Table 4 gives the list of few outsourcing drivers.

Table 4: List of IS Outsourcing Drivers

IS Outsourcing Drivers
(a) Outsourcing of Information Systems leads to lower cost of ownership.
(b) IS acquisition through outsourcing has low setup cost.
(c) IS acquisition through outsourcing has low set-up time.
(d) Shortage of skilled man power.
(e) Expertise of Outsourcer.
(f) Bank needs to focus on core banking functions rather than IT activities.
(g) Low Down time.
(h) Improved output/performance of Information Systems.
(i) Better service to users and customers.
(j) High cost of maintaining and updating IT employees.

IS Outsourcing Barriers

There need to be some care taken while implement-

ing an outsourcing decision. These refer to some risks involved in outsourcing the information systems and are referred to as *IS outsourcing barriers* which would discourage outsourcing these information system services. Glass (2000) in a editor's column predicted 'The end of Outsourcing Era by 2020'. It points that IS outsourcing that expects companies to lead to their financial transfusion and technological payoff would result in 'painful bloodletting'. These outsourcing barriers may be as varied as overdependance on external vendor, security of business plans and other information, high operating costs, loss of information systems related expertise. A list of the outsourcing barriers is given below.

- Over-dependence on Outsourcer.
- Difficulty in changing/modifying Information Systems.
- Security of Information Systems.
- Inability of Outsourcer to understand business needs of organization.
- Resistance from organization's employees.
- Resistance from IS personnel
- Higher Costs.
- Retrenchment of IS personnel due to IS Outsourcing.
- Loss of IS expertise

The manager, while deciding on outsourcing its information systems, should determine the reasons which drive the company for outsourcing information systems and at the same time should also consider the likely potential risks associated with this outsourcing decision to prepare the company for such contingent situations and also incorporate the suitable countermeasures for such risks.

Implementation Techniques for IS Outsourcing Framework

There are various critical steps in the framework, which require creative thinking. To implement the framework generously, it is suggested to apply apart from simple cost-benefit analysis, techniques for creative problem solving should be used. Therefore a checklist of possible methods is also presented in Table 5. While applying the framework, IS practitioners can use any of the suggested methods at these steps and formulate suitable outsourcing strategy for the organization.

Table 5: List of Techniques for Implementing Framework

S. No.	Critical Stages in Framework	Available techniques
1.	Defining Business goals & Business Strategic orientation	TKJ Brainstorming technique, Morphological Analysis
2.	Defining IS mission, goals & objectives, IS Strengths and Limitations, IS Strategy	TKJ Brainstorming technique, Morphological Analysis, SWOT Analysis
3.	Developing IS Strategic Alignment	Dialectical Approach, Brain Storming, Nominal Group Technique
4.	Identifying Outsourcing drivers and Outsourcing barriers	Dialectic Approach, Brain Storming, ABC (Pareto) Analysis
5.	Determining the Degree of IS outsourcing	Critical Questioning Technique, Analytical Hierarchy Process, Cost-Benefit Analysis
6.	Assessing the short, medium & long-term impact of outsourcing	Delphi, Brain Storming, Scenario Building, Cause & Effect Analysis
7.	Implementation Plan	Interpretive Structural Modeling, Attribute Listing, Cost–Benefit Analysis

Relevance of the Framework

IS outsourcing is a complex decision process, which is the interplay of various factors: internal as well as external environmental factors. We have tried to cover broad factors that give flexibility to practitioners to account for different sub-factors under these factors. Consideration of these might lead to a framework with following strengths:

- A multi-paradigm approach to develop information systems outsourcing strategy for any company: It provides the management a systematic approach to design the information systems structure considering the various activities related to IS processes and the form of outsourcing including the extent of outsourcing.
- Creating a strategic fit between the business goals and the information systems capabilities and orientation of any company. It helps the managers to create the desired IS infrastructure through outsourcing strategy wherein an optimum level of benefits of outsourcing are generated while keeping the risks of outsourcing at a minimum.
- Flexible and modular approach. It considers various factors internal as well as external that

prompt for outsourcing and also factors for the likely risks of outsourcing.

- Providing combination of analytical and creative techniques: The former takes a structured analysis route by systematically probing and decomposing the business requirements, positioning the strategic role of banks with respect to its information systems. The latter has at its disposal several creative problem-solving techniques to arrive at innovative solutions.

Conclusion

In the last few years, companies have explored outsourcing to address the increasing complexities in Information Systems. While few companies have reported neutral to positive results from IS outsourcing, there are also cases wherein companies have observed painful experiences from outsourcing. Further, a few studies have reported a lack of systematic approach followed in outsourcing decisions by managers. Apparently there is a gap in understanding of IS outsourcing among the practicing managers in such a domain. Hence there is need felt to provide a body of knowledge that is primarily addressed to practitioners. This paper reviewed some of the important factors that an IS outsourcing framework would entail, taking a systematic approach to IS outsourcing process. Consideration of these factors into a framework would help managers develop the IS outsourcing roadmap that is uniquely suitable for their company. Future scope lies in developing and validating a full blown framework that would help the company to design an IS outsourcing structure, providing a step-by-step approach to undertake the outsourcing process.

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Feature

Effect of Personality on Problem Solving and Decision Making

Daisy Chauhan & S.P. Chauhan

Personality shapes the behaviour of individuals as it is the personality that determines the way we react and interact with others. Our personality has a significant effect on two of the most important managerial functions: problem solving and decision-making. A study was carried out to identify the types of a group of 253 upper-middle and top level managers and link these findings of earlier research on personality and decision-making. It was found that almost 50 per cent of the managers were of three personality types: ESTJ (Extrovert, Sensing, Thinking and Judging), ENTP (Extrovert, Intuitive, Thinking and Perceiving) and ENTJ (Extrovert, Intuitive, Thinking and Judging).

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People differ from each other in many ways. They have different values, beliefs, needs and drives, impulses, and urges. They perceive, comprehend, understand and conceptualise differently. And of course, it goes without saying that these variations would necessarily lead to differences in behaviour patterns among individuals. These basic differences among individuals can be studied by understanding the different personality types.

The concept of personality is used widely. Personality is the way an individual acts (behaves) reacts and interacts with others. Just as no two persons are alike and they differ in physical characteristics, so we all have different "shaped" personalities. Learning about our Personality Type helps us to understand why certain areas in life come easily to us, and others are more of a struggle. Learning about other people's Personality Types help us to understand the most effective way to communicate with them, and how they function best. Organizations consist of employees who differ from one another on almost every dimension possible. Diversity certainly is a challenge that is here to stay. In the world of work, understanding how others function is a very important step in working effectively with them.

Literature Survey

There are two sides to personality, one of which is temperament and the other character (Keirsey, 1998). Temperament is a configuration of inclinations, while character is a configuration of habits. Character is disposition, temperament pre-disposition. Each type of creature, unless arrested in its maturation by an unfavorable environment, develops the habit appropriate to its temperament. In other words, our brain is a sort of computer which has temperament for its hardware and character for its software. The hardware is the physical base from which character emerges, giving rise to an individual's

attitudes and actions. This underlying consistency can be observed from a very early age – some features earlier than others – even before individual's experience or social context has had time or occasion to influence the person. Thus temperament is the inborn form of human nature; character, the emergent form, which develops through the interaction of temperament and environment.

Carl Jung first developed the theory that individuals have a psychological type. He believed that there were two basic kinds of "functions" which humans used in their lives: how we take in information (how we "perceive" things), and how we make decisions. He believed that within these two categories, there were two opposite ways of functioning. We can perceive information via 1) our senses, or 2) our intuition. We can make decisions based on 1) objective logic, or 2) subjective feelings. Jung believed that we all use these four functions in our lives, but that each individual uses the different functions with a varying amount of success and frequency. He believed that we could identify an order of preference for these functions within individuals. The function which is used most frequently by a person is his "dominant" function. He asserted that individuals are either "extraverted" or "introverted" as their dominant function. He felt that the dominant function was so important, that it overshadowed all of the other functions in terms of defining personality type. The developed theory today is that every individual has a primary mode of operation within four categories:

1. our flow of energy
2. how we take in information
3. how we prefer to make decisions
4. the basic day-to-day lifestyle that we prefer

Within each of these categories, we "prefer" to be either:

1. Extraverted or Introverted
2. Sensing or intuitive
3. Thinking or Feeling
4. Judging or Perceiving

We all naturally use one mode of operation within each category more easily and more frequently than we use the other mode of operation. So, we are said to "prefer" one function over the other. The combination of our four "preferences" defines our personality type. Although everybody functions across the entire spectrum of preferences, each individual has a natural preference which leans in one direction or the other within the four categories.

Now let us examine each of the four categories. Our Flow of Energy defines how we derive energy. We may receive it from within ourselves (Introverted) or from external sources (Extraverted).

The second aspect deals with how we prefer to Take in Information and absorb it. We may depend on our five senses (Sensing) to take in information, or we may rely on our instincts (intuitive).

The third type of preference, how we prefer to Make Decisions, refers to whether we are prone to decide things based on logic and objective consideration (Thinking), or based on our personal, subjective value systems (Feeling).

These first three preferences were the basis of Jung's theory of Personality Types. Isabel Briggs Myers developed the theory of the fourth preference, which is concerned with how we deal with the external world on a Day-to-day Basis. Are we organized and purposeful, and more comfortable with scheduled, structured environments (Judging), or are we flexible and diverse, and more comfortable with open, casual environments (Perceiving)?

Booz, Allen & Hamilton tried to find some universal characteristics among executives. They suggested eight executive characteristics which can distinguish the promotable from the non-promotable. These are: Position performance, Drive, Intellectual ability, Leadership, Administration, Initiative, Motivation, and Creativeness. These traits are also considered significant (Packard, 1962). In relation to goal attainment Buss (1991) has discussed personality characteristics as dispositional motives utilized during goal attainment. That is, personality characteristics predispose humans to behave in certain ways, given particular situations, to accomplish certain goals, and so forth (e.g. Buss, 1989; Costa & McCrae, 1992). If we have a better understanding about our personality type and those of others, we are empowered with an understanding of why people react differently in different situations and it is quite likely that we will find it easier to accept and understand people's behaviours that are different from ours.

Knowledge of Psychological Type is a powerful aid in our quest for excellence, but it is not the actual solution. It is a model that will help in expanding our understanding of human nature. An improved understanding of self and others will help us to find, follow or expand

our path. If we have a better understanding about our personality type and those of others, we are empowered with an understanding of why people react differently in different situations and it is quite likely that we will find it easier to accept and understand people's behaviours that are different from ours (Chauhan & Chauhan, 2006). An awareness and acceptance of the fact that one personality function may be more effective than another function in a given situation will help us to understand its relevance and the need to adapt to various situations in life.

According to Mcdonald & Hutcheson (1998) the most basic determinant of the work role one is best suited for is one's natural abilities. However, another important determinant is one's personality – his typical style and preference for interacting with other people. Personality tells you how you work most effectively and efficiently with others, and with the least stress. There is strong research evidence that personality assessment contributes unique knowledge about the individual that can be used to make more accurate predictions of job performance. Research has also consistently shown that, in addition to knowledge, skills and abilities, personality is an important predictor of job performance, particularly contextual performance and determining person-organization fit. Structured personality assessment combined with other validated assessment methods (e.g., cognitive ability, assessment centres, structured interviews) might enhance the HR practitioners' ability to match individuals to jobs or roles.

Recent research has clearly demonstrated that personality is a valid predictor of job performance, particularly when the unique personality requirements of the job have been accurately identified. Personality assessment is extremely useful in predicting contextual job performance as opposed to technical aspects of job performance (contextual performance being described, typically, as the "soft side" of work – interpersonal effectiveness, person-organization fit, etc.). In staffing practices, personality can influence either explicitly or implicitly in decision-making, usually through personal suitability factors. According to Raymark, Schmit, & Guion, (1997) the predictive utility of personality assessment is enhanced when job type and personality constructs are matched, either based on the findings of previous research, rational analysis, or a thorough personality oriented job analysis. This is to say, different jobs demand different personality profiles (Hogan, 1996). For example, Intuitive-Thinking types are over-represented at higher levels of management and Sensing-Thinking are over-represented at lower management levels as there are differences in role demands between middle and senior management positions – i.e. , the tasks at senior levels, such as visioning and strategy formulation tend to be more abstract versus the more concrete tasks found at lower management levels. These abstract types of tasks at the higher level require a more intuitive approach for successful completion (Gardner & Martinko, 1996).

The Sixteen Personality Types

The possible combinations of the basic preferences yield 16 different Personality Types. Carl Jung, Katharine C. Briggs, and Isabel Briggs Myers identified sixteen personality types. This does not mean that all (or even most) individuals will fall strictly into one category or another. We all function in all of these realms on a daily basis. As we grow and learn, most of us develop the ability to function well in realms which are not native to our basic personalities. Based on the experiences of our life, we develop some areas of ourselves more thoroughly than other areas.

According to Lawrence (1993), Keirsey and Bates, (1984) a study of personality type becomes relevant when we find an individual's functioning is affected by how he relates to the world by being Extrovert or Introvert, how he processes information by being Intuitive or Sensing, evaluates the environment by being Judging or Perceiving; and finally makes decisions by being Thinking or Feeling. Thus personality type can influence human behaviour and thereby job performance to a great extent.

Present Study

A study was carried out on 253 executives, mostly from the upper-middle and top levels of management in various organizations. The managers were administered the Personality Style Inventory (Hogan & Champagne, 1980). The questionnaire consisted of 60 pairs of statements. The purpose of this study is to attempt to understand individual preferences as exhibited by the personality and link the findings of this study with the findings of earlier research on personality type and the influence of personality types on important managerial functions like problem solving and decision making.

Findings

An analysis of the data indicates that the sample under study pre-dominantly consists of managers who are extroverts, intuitive, thinking and judging type as shown in the Table 1.

Table 1: Details of break-up of Personality components

Extroverts – 184 (72.73%)	Introverts – 69 (27.27%)
Sensing – 96 (37.94%)	Intuitive – 157 (62.06%)
Thinking – 198 (78.26%)	Feeling – 55 (21.74%)
Judging – 156 (61.66%)	Perceiving – 97 (38.34%)

The characteristics of each of the personality types based on earlier research are detailed in Table 2. Temperament, character, and personality are configured, which means that, not only are we predisposed to develop certain attitudes and not others, certain actions and not others, but that these actions and attitudes are unified — they hang together in combinations. These combinations are as follows: NT, SJ, NF and SP (Keirsey, 1998). An analysis of the data collected for the present study was carried out to find out the dominant temperament in the present sample and compare it with earlier findings. Details of the analysis is given in table 4.

Table 2: Personality Characteristics

Extroverts	• Enjoy participating in meetings and work teams, generating ideasenergized by people and action • outward orientation • sociable, expressive, external • extrovert wants breadth vs depth • may act before thinking-think out loud
Introverts	• Are shy or aloof, seldom take initiative and actively participate in meetings • focus on their perceptions inwardly • deal with inner world of ideas - would rather listen than talk • needs private time to recharge • could feel underestimated introvert can learn extrovert game to succeed • can do well in human/public relations
Sensing: The Realists	• Seek specific answers to specific questions, enjoy practical tasks with tangible results, focus on the present, prefer working with facts/ data rather than with imagination. • no nonsense • pay attention to information from sensory channels • seeing is believing-focus on here and now • enjoy what is now rather than past or present • focus on details, facts of situations, people and events • greatest trust is experience - likes set procedures and routines • deviation is not welcomed - like to look at things in parts or pieces • sequential approach • like hands on, concrete work
Intuitives: The Innovators	• Enjoy thought experiments, speculation and theory building, and they seek generalities rather than specifics. Their preference is for a more figurative, random way of gathering information. They are often said to be "having their head in the clouds". • like to use 6th sense, hunch • like variety-future orientation • possibility thinkers-love to be inventive • bored by routine-can jump in anytime • look for pattern relationships, designs rather than pieces or parts of whole • whole is first object of attention
Thinkers: Life's Logician	• Pride themselves on their logic, analytic ability, objectivity and impersonality – believing it is more important to be right than to be liked, and they lend more credence to logic and rationality. • take logical approach • careful consideration to justify action • look at the consequences in an unbiased way • search for truth - intellectual orientation to life • truthful rather than tactful • value fairness over compassion
Feelers: Life's Lovers	• Seek harmony rather than fairness or clarity, tend to overextend themselves to meet others' needs, and consider a "good" decision one that takes others' feelings into account. With a tender hearted approach to decisions, they prefer subjectivity and interpersonal considerations to the hard facts. • base decision on emotions and personal values • logic may be used to support feeling decision • the people's people • prefer tact over truth • more compassionate than firm • humane and personally involved
Judgers: Life's Organisers	• Prefer decisiveness, planning, punctuality, order, tidiness, organisation, adherence to schedules and control. "A place for everything and everything in its place" is their motto • tend to create structured environment • everything organized and planned • well organized, structured and decisive • need closure on matters • enjoy decision making: These things give them control
Perceivers: Mellow Types	• Prefer flexibility, spontaneity, adaptiveness and they dislike structure and routine. • live a different lifestyle • live for spontaneity • last minute change as opportunity • open to possibilities • uncomfortable being forced into quick conclusion - desire to learn more • tolerant and adaptable • live and let live • go with flow

Some of the important aspects of each personality trait in relation to problem solving and decision-making are explained in Table 3:

Table 3: Aspects of personality important for problem solving and decision making

MBTI Dimension	Orientation	Criteria for Judging Effectiveness	Techniques	Strengths
Extravert	Outside world of people and things	Can "talk through" problem in group Works in "real world"	Brainstorming, Thinking aloud, psychodrama	Attend to external reality, Listen to others
Introvert	Inner world of ideas	Internal logic, value of ideas, Want to reflect on problems	Brainstorming, privately Incubation	Attend to internal consistency of solutions
Sensing	Facts and details from past and present	Personal experience, Practicality of solutions, Conforms to standards	Share personal values, ideas, facts, Inductive reasoning, Random word technique	Attend to details, What could go wrong, Develop and implement specific steps of solution
Intuitive	Concepts and principles, Possibilities for future	Meaningfulness of facts, details, Solutions consider total situation Prospect for originality	Classify, categorize, Deductive reasoning, Challenge assumptions, Imaging/ visualization, Synthesizing	See connections and links Develop complex solutions, Implications of improper solution(s), Develop major phases
Thinking	Objectivity, Logic and reason	Solutions make sense based on facts, models, and/or principles	Classify, categorize, Analysis, Network analysis, Task analysis	Attend to internal and external consistencies, Evaluate for efficiency and effectiveness
Feeling	Subjectivity Values and affect	Solutions consider impact on people	Share personal values, Listen to others' values, Values clarification	Evaluate for impact on people, Evaluate in terms of being valued by participants
Judging	Organization, Structure and closure	Decisions are made, Solution can be Implemented, A step-by-step procedure to follow	Evaluation, PMI technique, Backward planning, Select single solution	Identify possible defects, Follow steps during Implementation,
Evaluate				for effectiveness and efficiency
Perceiving	Data gathering, Processing solutions	Solutions are flexible and adaptable, Enough information provided in solution, Variety of alternatives considered	Brainstorming, Random word technique, Outrageous provocation, Taking another's perspective	Develop complex solutions, Flexibility

Source: Huitt, W. (1992). Problem solving and decision making: Consideration of individual differences using the Myers-Briggs Type Indicator. Journal of Psychological Type, 24, 33-44.

Table 4: Details of Temperaments in terms of Percentages

Personality Type	Present Finding	Earlier Findings
Intuitive-Thinking (NT)	97 (38.34%)	5-7%
Sensing-Judging (SJ)	88 (34.78%)	40-45%
Intuitive-Feeling (NF)	36 (14.23%)	8-10%
Sensing-Perceiving (SP)	32 (12.65%)	35-40%

As can be observed from the above figures, the dominant temperaments in the present sample was that of NT (38%) and SJ (35%). The major deviations from earlier research is that the sample under study has majority of the managers who are intuitive thinkers (NT) whereas they formed only 5-7% of the population in earlier findings. On the other hand the second dominant temperament was SPs according to earlier research whereas it was the least dominant one in the current study. The findings regarding SJ and NF were somewhat similar to earlier findings. One of the reasons that could be attributed to the larger percentage of intuitive thinkers in the present study could be because the sample comprised of middle and senior levels of management. Intuitive-Thinking types are over-represented at higher levels of management and Sensing-Thinking are over-represented at lower management levels. This makes sense when one considers the differences in role demands between senior management positions – i.e., the tasks at senior levels, such as visioning and strategy formulation tend to be more abstract versus the more concrete tasks found at lower management levels. These abstract types of tasks at higher level require a more intuitive approach for successful completion (Gardner & Martinko, 1996).

Research indicates that SPs base their self-image on graceful action, bold spirit, and adaptability to circumstances, these three traits evolving together out of necessity. Furthermore, these three traits, developing together as if out of a single seed, preclude the emergence of a self-image based on, say, empathy, benevolence, and authenticity, which are characteristics of the NFs. In the same way, the SJs base their self-image on reliability, service, and respectability, these three traits emerging together as a unified structure of personality. SJs seek to belong to meaningful institutions. Practical and realistic, they thrive by procedure and organisation. Their strengths are administration, dependability, the ability to take charge, and respecting organizational hierarchies. And again, the unfolding of these three traits together weighs against developing a self-image based on ingenuity, autonomy, and willpower, which is characteristic of the NTs.

The findings of the present study is indicative of a pool of managers with the dominant characteristics of NTs (38%) and SJs (35%). NTs are characterized by ingenuity, autonomy and willpower who pursue excellence and SJs characterized by reliability, service and respectability who are practical and realistic. NTs maintain their own standards and benchmarks for what is competent, and they relentlessly pursue excellence. They are frequently perceived by others as aloof, intellectual snobs. In work settings, NTs tend to be strategic planners and researchers, but they can get lost in the strategies and overlook day-to-day business. SJs seek to belong to meaningful institutions. Practical and realistic, they thrive by procedure and organisation. Their strengths are administration, dependability, the ability to take charge, and respecting organisational hierarchies.

This seems to be a right combination to have as we have some managers who are innovative and an almost equal number who are practical and realistic. We have a set of managers who are future-oriented and another set who live in the present.

In terms of personality types the findings of the study are given below:

In the present sample the two dominant personality types are ESTJ (20.15%) and ENTP (15.01%) followed by ENTJ (12.65%) and ISTJ (9.09%). It was found that almost 50 per cent of the managers were of three personality types: ESTJ, ENTP and ENTJ. Further, two dominant personality types of ESTJ and ENTP account for 35% of the entire sample. Thus we have a group of managers (ESTJ) who are grounded in the realities of the environment and at the same time we also have a group of managers (ENTP) who are sensitive to the possibilities are non-conformist and are innovative. This is a very positive indication as we have the right combination of managers who are creative and innovative and at the same time there are others who are realistic as well.

Table 5: Personality and Problem Solving

Temperament	Goal	Important Elements	Preferred Processes & Techniques	Need Help
SJ	Follow Tradition, Fulfill Duty	Oriented to past, present. Loyal, helpful, useful to social units.Value evolutionary change	Prefer going step-by-step. Prefer known solutions that work. Task analysis Simulations	Categorizing and classifying,Generating creative alternatives
NT	Understand, control, and explain reality. Acquisition of competencies	Use of logic and reason. Oriented to future. Logical correctness of principles and concepts.	Model development, Challenging assumptions. Structured controversy, Model development	Attending to facts and details.Looking at impact on people
NF	Becoming. Self-discovery	Oriented to future, Possibilities for people. Value intuition and inspiration	Self-analysis, Values clarification	Attending to facts and details. Developing realistic alternatives, Carefully monitor implementation
SP	Take Action	Oriented to present. Adaptable, flexible, reality-oriented, Value own experiences,Flexible process for defining and solving	Iterative approach to process simulations, Role playing, Subcommittees to work out details and step-by-step plan	Coherence of plan, Following selected solutions

Source: Huitt, W. (1992). Problem solving and decision making: Consideration of individual differences using the Myers-Briggs Type Indicator. Journal of Psychological Type, 24, 33-44.

Table 6: Details of Personality Types and Characteristics of Dominant Personality Types

Personality Type	% of Sample	Earlier Research
ESTJ	51 (20.15%)	13%
ESTJ: "Administrator". Much in touch with the external environment. Very responsible. Pillar of strength. 13% of the total population.		
ENTP	38 (15.01%)	5%
ENTP: "Inventor". Enthusiastic interest in everything and always sensitive to possibilities. Non-conformist and innovative. 5% of the total population.		
ENTJ	32 (12.65%)	5%
ENTJ: "Field Marshall". The basic driving force and need is to lead. Tend to seek a position of responsibility and enjoys being an executive. 5% of the total population.		
ISTJ	23 (9.09%)	6%
ISTJ: "Trustee". Decisiveness in practical affairs. Guardian of time-honored institutions. Dependable. 6% of the total population.		
ESTP	17 (6.72%)	13%
INTJ	17 (6.72%)	1%
ENFP	16 (6.32%)	5%
ENFJ	14 (5.53%)	5%
ESFJ	12 (4.74%)	13%
INTP	10 (3.95%)	1%
ISTP	09)	5%
ESFP	04)	13%
INFJ	04) = 23 (9.09%)	1%
ISFJ	02)	6%
ISFP	02)	5%
INFP	02)	1%

It may also be observed from the table that the above four personality types account for 56.74% of the total sample size while the remaining 12 personality types account for 43.26%. Further, seven personality types (ESTJ, ENTP, ENTJ, ISTJ, ESTP, INJT, ENFP) account for 76.67% whereas the remaining 9 personality types account for only 23.33% only. Nearly 70% of the sample are predominantly thinking type as shown in bold print in Table 6.

Personality and Problem-Solving

Each of the above aspects of personality would influence the problem solving and decision making of individuals. Researchers have investigated the relationship of Jung's theory of individuals' preferences and their approach to problem solving and decision making (e.g., Lawrence, 1982, 1984; McCaulley, 1987; Myers & McCaulley, 1985).

For example while solving problems extroverts would prefer to discuss their ideas with others to clarify them whereas introverts would take time to think and clarify their ideas before talking about it to others. Extroverts would like to seek feedback from others about the viability of their ideas while introverts would be more concerned about their own understanding of the concept and idea.

Sensing individuals are likely to pay attention to facts, details and the reality and would prefer standard solutions which have worked in the past. On the other hand Intuitive individuals would be more interested in understanding the meaningfulness of the facts, the relationship among the facts and the possibilities for the future based on the available facts.

Individuals with a thinking orientation would prefer to use logic and analysis for problem solving and would be concerned about objectivity and would tend to be impersonal in drawing conclusions and arriving at decisions. Individuals with a feeling orientation would be governed by values and feelings in the problem-solving process. They tend to be subjective in their decision making and focus more on how their decisions would affect people.

Finally individuals who are the judging type are more likely to prefer structure and organisation and would aim at a closure for problem solving. To that extent they would prefer to plan and proceed rather than being open to changes. Perceiving types are more likely to be flexible

and adaptable. They would prefer to consider various alternatives and yet leave scope for unforeseen change.

Huitt (1992) has analysed the different temperaments (SP, SJ, NT and NF) in relation to problem solving: The SP temperament is oriented to reality in an adaptable manner. The goal of the SP is action, and the SP's time reference is the present. The SP wants to take some immediate action using an iterative approach to achieve the end result or goal. The SP's definition of the problem is likely to change in the process of solving it. Individuals of this temperament are not likely to be bound by original perceptions and want the freedom to change their perceptions based on new information. Sometimes lack of a coherent plan of action diverts the SP from the original problem.

An individual of the SJ temperament is oriented to reality in an organized manner, strives to be socially useful, and performs traditional duties within a structured framework. SJs are detail conscious, are able to anticipate outcomes, and prefer evolutionary rather than revolutionary change. SJs often need help in categorizing details into meaningful patterns and generating creative, non-standard alternatives.

The NT temperament approaches problem solving scientifically and is future oriented. NTs are likely to be interested in the laws or principles governing a situation. The prescriptive problem-solving/decision-making process described by researchers is oriented to the NT temperament. NTs tend to overlook important facts and details and need help considering the impact of solutions on people.

The NF temperament seeks self-discovery, which appears to be a circular goal, and is oriented to the future in terms of human possibilities. When engaged in the problem-solving process, NFs may rely on internal alternatives often interpreted as not grounded in reality or logic. They are often concerned with the integrity of solutions and strive to enhance personal development. NFs need help attending to details and focusing on realistic, formulated solutions.

Personality and Decision-making

Research on decision styles has identified four different individual approaches to making decisions (Rowe, and Boulgarides 1992). The basic foundation of this model is the recognition that people differ along two dimensions. The first one is on their way of thinking and the second is their tolerance of ambiguity. As far as thinking is concerned, some people are logical and rational. They process information serially. In contrast, some are intuitive and creative. They perceive things as a whole. On the second dimension of tolerance of ambiguity, some have a high need to structure information in ways that minimize ambiguity, while others are able to process many thoughts at the same time. When these two dimensions are combined they yield four styles of decision making. These are directive, analytic, conceptual and behavioural. People using a directive style have low tolerance for ambiguity and seek rationality. They are efficient and logical, but their efficiency concerns result in decisions made with clear and factual information and with few alternatives assessed. They focus on facts and this characteristic is a dominant feature of the sensing personality type who rely on their senses for collecting information for decision making. They are fast in decision making and their focus is on the short run.

The analytic type has a much greater tolerance for ambiguity than do directive decision makers. This leads to the desire for more information and consideration of more alternatives than the directives. Analytic managers are careful decision makers. Individuals with conceptual style tend to be very broad in their outlook and consider many alternatives. Their focus is long range and they are very good at finding creative solutions to problems. The individuals with a conceptual decision making style fall in the category of Intuitives who are able to see the broader perspective or the whole picture from bits and pieces of information.

Individuals with a behavioural style of decision making are concerned with working well with others. They are receptive to suggestions from others, relying heavily on meetings for communicating. They try to avoid conflict and seek acceptance or consensus. These characteristics are found among the perceiving type of personality as they are more concerned about the impact of their decisions on others. On the other hand conceptual decision makers are innovative and willing to take risks, but they are often indecisive. Managers with a behavioural style of decision-making tend to take a soft approach even when hard decisions are warranted as they are more concerned with avoiding conflict.

Conclusions and Implications

The findings of the present study is indicative of managers using a directive as well as analytical approach to problem solving and decision making. The implications of style of decision-making is that directive managers are good decision makers in situations which are struc-

tured, certain and unambiguous, but may not be very effective in complex situations with little information available. Analytical decision makers make fast decisions but they also tend to be autocratic in their approach to doing things.

Since personality type has some correlation with job preferences and the tendency to excel in certain jobs it would be worthwhile to supplement the assessment of personality profile with various other process like interview, presentation etc. for job selection and promotion so that organizations can ensure a better person-job-fit which could be a step in the right direction towards realizing the potential of individuals towards personal development and achievement of organisational goals. Based on evidence from current research, it can be concluded that structured personality assessment for the purpose of predicting job performance is promising, and provides an area of exploration and further research. Furnham (1994) opinioned that there is a widespread use of personality tests by organisations interested in improving recruitment, selection, development, and promotional procedures. Knowledge of personality will help to:

- Increase employee performance by matching work styles with personality types
- Increase management effectiveness by improving teamwork
- Increase organizational growth by identifying and selecting effective leaders
- become aware of the negative aspects of our personality and work towards overcoming those weaknesses.

Personality questionnaires can be used to assess all types of staff for a range of applications like: Selection and placement; Performance Management; Management Development; Counseling; Organizational Development; and Occupational research

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Feature

Management of Remanufacturing Business – A Critical Study of a Photocopier Remanufacturer

Kampan Mukherjee & Sandeep Mondal

Remanufacturing is an attractive business option involving the process of value recovery and reuse of used products. Even though it has been accepted by the western world, India is yet to take it up as an organised industrial sector. With this backdrop, an attempt is made to study the various managerial activities of a reputed Indian company, which is engaged in remanufacturing photocopiers as an additional business option. This paper includes a critical examination of relevant issues in managing the remanufacturing process and discussion on the case study subsequently leads to exploring possible directions for management research in remanufacturing, particularly applicable to the Indian industrial sector.

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Remanufacturing is a type of product recovery process, where used and discarded products/components/parts are subjected to a sequence of activities, so as to convert them into reusable ones. Since used products (returns) form the basic raw materials in this set of activity, the process begins with acquiring returns from the disposer market (returns acquisition management), which is then followed by transporting these returns to the remanufacturing plant through a logistics chain (Reverse Logistics). Further, at the remanufacturing site, these returns are completely disassembled to the level of parts and components. The parts/components are thoroughly inspected, defective and worn out parts are repaired or replaced by new ones and then reassembled to build up the remanufactured product. With respect to the quality, a remanufactured item is 'as-good-as-new'. Technological upgradation of some parts or modules is also possible during the remanufacturing process (Fleischmann et al., 2000; Dekker et al., 2000; Thierry et al., 1995; Guide et al., 2003c).

The increasing concerns over environmental issues, take-back obligations and disposal bans along with growing environmental awareness among customers and the economic benefits from remanufacturing are found to be the prime reasons which motivated the industry towards reuse, remanufacturing and recycling of used and discarded products (Thierry et al., 1995). Various European countries and several states of US have stringent laws on reuse like the take-back programmes of Denmark, Germany, The Netherlands, Norway and Switzerland, European Union's directive on Waste from Electrical and Electronic Equipment (WEEE), End-of-Life Vehicles (ELV) take-back policies of Germany, The Netherlands and France, the Universal Waste Rule (1995) of North America. Japan's Extended Producer Responsibility (EPR) law is also an example of regulatory

measure as a representative case from Asia (Guide et al., 2000; Guide et al., 2001; Doppelt et al, 2001; Spicer et al., 2004). These laws had made it mandatory for companies to adopt the product recovery activities in order to continue their business in those countries.

Other than legislative compulsions, industries found that product recovery activities are economically more attractive than disposing off the used products, particularly in countries like US and EU (Dekker et al., 2000; Mukherjee, 2002). A remanufactured item is often cheaper than a new one as the processing and manufacturing expenditure (time, energy, cost, etc.) are avoided. It is estimated that product recovery activities can save 40 to 60% of the cost of manufacturing a new product, while requiring only 20% of the energy (Guide et al., 1997a). Xerox estimates cost savings of $76 million in 1999 from product recovery programme (Guide et al., 2003b). Profit from remanufacturing activities is almost around 20%, although in the automotive sector it may go up to 30 ± 10%. Price of remanufactured items is generally 30 to 40% of a new one. Thus a remanufactured item which is cheaper can become popular, particularly in lesser-developed markets. For example, the cost of an expensive product such as a bus, when remanufactured, reduces from $220,000 for a new one to $70,000 for a remanufactured one (Amezquita et al., 1995). Significant price difference like this can create a huge demand for the recovered or remanufactured products. In US itself there are over 70000 remanufacturing firms with total sales of $53 billion (Lund, 1998). These firms directly employ 350,000 workers and their average profit margins exceed 20% (Nasr et al., 1998).

Further, many corporates have taken up voluntary take-back programmes. FujiFilm for example, purchases its cameras back, Kodak has initiated design-for-the-environment in their cameras and reuses 86% (by weight) of all the cameras. The reason behind this is to build a green corporate image and thus to attract the environmentally conscious customers, which ultimately contributes to sales growth. IBM Europe, Digital Europe and Xerox could also create customer image by product recovery activities, resulting to better economic benefits (Guide et al., 2000).

A wide range of products are being remanufactured world-wide like automotive parts, locomotives, buses, aircrafts, engines, machine tools, electronic equipment, photocopiers, cellular phones, computers, consumer durables, etc. But this practice is still in its nascent stage in many African, South American and Asian countries including India. This paper aims at studying and understanding the remanufacturing process of an Indian company.

Literature review

Remanufacturing activities have been gaining momentum in the Western World, particularly in US and many European countries like The Netherlands, Germany, Denmark etc. Researchers and management scientists have also taken this up as one of the emerging areas and various studies have been completed pertaining to relevant business issues, management decisions, reverse logistics networks, production planning and inventory decisions etc. In this context, the noteworthy contribution of the team members in European Union sponsored REVLOG project is to be acknowledged and mentioned (Brito et al., 2004a). Rochester Institute of Technology's National Center for Remanufacturing and Resource Recovery is another leading center for applied research in remanufacturing (www.reman.rit.edu). Similar works have been initiated by many other universities around the globe.

We refer to Gungor et al. (1999) (331 articles and books) and Brito et al. (2002) (121 articles, books and web-sites) for their extensive review of literature on product recovery and reverse logistics. A thorough discussion on literature relevant to production planning and control is presented in Guide et al. (1999). In the review of remanufacturing literature, we would primarily focus on contributions that attempt to lay the fundamentals of remanufacturing from managerial standpoint, i.e., a general body of principles explaining remanufacturing issues, addressing a variety of decision-making problems, case examples and empirical investigations pertaining to managerial insights and strategy formulations. The reviewed articles are initially classified into two broad groups on the basis of two perspectives – the strategic and environmental issues, and the operational management issues.

The former group of remanufacturing literature covers research reports addressing three areas of concern (or subgroups), preferably expressed as strategic and economics related issues, product design related issues, and environment related issues. The latter group of remanufacturing literature is further sub-classified according to six decision areas – production planning and control, reverse logistics, inventory management, returns acquisition management, market structure and profitability analysis for remanufactured product. The sixth subgroup under operational issues however, emphasises on costs and economic benefits for any remanufacturing organisation, which justifies its inclusion in the operations management group. Each of these groups and subgroups highlights certain set of characteristics and research directions, which lead to form a conceptual framework of the remanufacturing process and capture the

uniqueness of this business process. Table 1 provides the general taxonomy of the remanufacturing literature showing this classification and sub-classification. It is expected that this taxonomy may represent the basic source of literature for undertaking any research project on remanufacturing management.

Table 1: Taxonomy of the remanufacturing literature

A. Strategic and Environmental Issues

1. Strategic and economic related
   - Recovery options in product recovery management (Thierry et al.,1995; Brito et al., 2004a)
   - Life cycle and end-of-life aspects (Stuart et al., 1999; Kerr et al., 2001; Nagel et al., 1999; Pappis et al., 2004)
   - Overall cost-benefit application of product recovery operations (Guide et al., 2001; Giuntini et al., 2003; Lebreton et al. (in press); Amini et al., 2005)
   - Macroeconomic importance of remanufacturing (Environmental Protection Agency, US, 1998)
   - Empirical and survey related study (Gotzel et al., 1999; Seitz et al., 2004; Mukherjee et al., 2004; Daugherty et al., 2005; Mondal et al., 2006b)
2. Product design
   - Design characteristics that facilitate remanufacturing of products (Amezquita et al., 1995; Kriwet et al., 1995; Hammond et al., 1998)
   - Design for remanufacturing (DFR) (Kalyan-Seshu et al., 1997; Ishii et al., 1995; Gungor et al., 1999)
   - Computer software that supports the design of a product in terms of disassemblability (Hesselbach et al. (1996)
   - Metrics for assessing the remanufacturability of a product design (Bras et al., 1996)
3. Environmental related
   - Impact of environmental legislation on remanufacturing (Doppelt et al., 2001)
   - Environmental strategy of a remanufacturer (Maslennikova et al., 2000; White et al., 2003; Sarkis, 1998)
   - Green supply chain management (Bloemhof-Ruwaard et al., 1995; Rao, 2002)
   - Impact of environmental issues in operations strategy (Corbett et al., 1993; Sarkis, 1999; Sarkis, 2001; Georgiadis et al., 2004)

B. Operational Issues in Remanufacturing

1. Production planning and control
   - Exploring issues in production planning and control (Guide, 2000; Guide et al., 2000; Guide et al., 2003b)
   - Disassembly planning (Johnson et al., 1995; Guide et al., 1997b; Guide et al., 1999; Lambert, 1999; Lambert, 2002)
   - Scheduling (Gupta et al., 1994; Guide et al., 1997c)
   - Capacity planning techniques (Guide et al., 1997d)
   - Reverse Wagner/Whitin's dynamic production planning (Richter et al., 2000)
   - Performance study of a remanufacturing shop (Guide et al., 2005)
2. Reverse logistics
   - General framework on reverse logistics networks (Fleischmann et al., 1997; Fleischmann et al., 2000; Fleischmann, 2001; Krumwiede et al., 2002; Brito et al., 2004a)
   - Overview of scientific literature and cases in reverse logistics activities (Brito et al., 2002)
   - Facility location model (Barros et al., 1998; Jayaraman et al., 1999; Louwers et al., 1999; Fleischmann et al., 2001; Berman et al., 2000; Listes et al., 2005)
   - Reverse logistics network design (Johnson, 1998; Shiu, 2001; Jayaraman et al., 2003; Nagurney et al., 2005)
   - Routing problem (Dethloff, 2001; Beullens et al., 2004)
   - Reverse logistics operating costs (Tung-Lai Hu et al., 2002; Savaskan et al., 2004)
   - Necessity of Information Technology in managing the complex and uncertain reverse logistics (Kokkinaki et al., 2004)
3. Inventory management
   - Overview and issue-based (Dekker et al., 2000)
   - Warehousing (Brito et al., 2004b)
   - MRP system (Guide et al., 1997a; Ferrer et al., 2001)
   - Optimal lot-size policies (Ferrer, 2003; Minner et al., 2004)
   - Model considering stochastic demand and return flow (Inderfurth, 1997; Heisig et al., 2001; Minner et al., 2001; Teunter et al., 2002b; Fleischmann et al., 2003; Mahadevan et al., 2003; Kiesmuller et al., 2003)
   - Dynamic demands and returns taking into consideration seasonality and product life cycle (Kleber et al., 2002)
   - PUSH and PULL controlled systems (Van der Laan et al., 1999)
   - EOQ models (Teunter, 2001; Shie-Gheun et al., 2002; Van der Laan, 2003; Mostard et al., 2006; Dobos et al., 2004)
   - Safety stock planning (Minner, 2001)Average cost inventory models (Teunter et al., 2002a)Optimal periodic policy (Inderfurth et al., 2004; Kiesmuller et al., 2003)
   - Stochastic hybrid manufacturing/remanufacturing problems (Inderfurth, 2004; Teunter et al., 2002c)
   - Opportunity cost rates (Teunter et al., 2000)Life cycle inventory analysis (Daniel et al., 2003)
4. Returns acquisition management
   - Development of a framework (Guide et al., 2001)
   - Approaches of implementation of returns take-back (Spicer et al., 2004)
   - Formulation of decision rules on handling of returns (Krikke et al., 1999)
   - Quantitative model to analyze the buy-back program (Klausner et al., 2000; Guide et al., 2003a; Mondal et al., 2006a)
5. Market competition for remanufactured products (Majumder et al., 2001)
6. Profitability analysis (Hoshino et al., 1995; Ferrer, 1997a; Ferrer 1997b; Guide et al., 2001; Guide et al., 2003a; Heese et al., 2005)

Background of the remanufacturing company under study

The company (an Original Equipment Manufacturer or OEM) under study is a well-known photocopier manufacturer in India. It is incorporated in the year 1983 and is a part of an MNC (with sales of $15.7 billion) and Fortune 500 global Document Management company. Over the past 20 years, the company has shaped the Document Management industry in India by ushering in the world's best document processing products (more than 100 in variety) and bringing innovative value-added concepts to cater to customer needs. It is the first in industry to achieve ISO 9002 for both, Manufacturing and Marketing/Customer Service Support and among the first 10 companies in India to obtain ISO 14001 for complete environment management systems. It has a world-class facility for manufacturing of copiers, consumables and parts, which makes it one of the top rated companies in India, particularly in overall customer satisfaction and service with its nationwide distribution and reach.

In 1991, the parent MNC set a goal to become a waste-free business house. It recognized a number of essential characteristics of a waste-free company: financial, competitive advantage, compliance with legislative regulation and meeting customer requirements. With the adoption of this end-of-life equipment take-back programme, it led to savings of over $80 million in Europe in 1997. Keeping this strategic goal in view, the OEM in India has also initiated the practice of their parent company by setting up a remanufacturing centre in 1998 as Asset Management Business Centre. This centre is engaged in remanufacturing its own photocopier machines under various brand names (currently three in number). The remanufacturing plant has been established around 2 km away from its manufacturing plant located in the northern region of the country. The remanufacturing plant is managed independently and is treated as a profit center, separated from its manufacturing business.

With the production facility for 60-70 units of monthly production, the sales turnover of the company from remanufacturing business has been around Rs 30 million in the year 2003. It is the only Indian company that pursues remanufacturing business of photocopiers in India and thus it enjoys a monopolistic market of this product. Moreover, the market for remanufactured photocopiers and the new products of the OEM are identified as two separate segments. In this case, the OEM manages all the basic remanufacturing operations including acquisition of the used products and reverse logistics activities through well-established network of supply chain (Type I Product Recovery System, as mentioned in Mondal et al., 2006a). The company involves both casual (or temporary) and permanent employees in its workforce. However, it opts for hiring more temporary workers than the permanent ones, particularly for some operations like, disassembly, cleaning, sorting and inspection, which are highly labour-intensive. This recruitment policy might have been chosen for getting some cost advantage and better management of workforce. Currently, there are only eleven permanent workers on role.

Although the primary motivation for remanufacturing business lies on the waste free policy or environment friendliness of the parent global company, adoption of remanufacturing by this Indian company is largely driven by its unique service policy to the customers for maintenance of the newly installed machines. According to this policy, it provides every new machine that is sold with free service and maintenance, excluding the cost of consumables, till its end-of-life (10 years approx.). By adopting such policy, the company not only maintains a close relationship with the customer but also keeps relevant information of all the installed machines through a strong network of service centres all over the country. However, the company has to bear an additional service cost for offering this policy of free service and for maintenance of such a service network. Now, it is observed that as the machine ages, the service cost on a unit also increases. So, high cost is to be borne for older machines.

Keeping this in view the company has initiated the 'exchange offer' and 'buy-back' scheme. Customers are given the option to get their old units replaced by new and upgraded models through 'exchange offers' or simply to sell the old units to the OEM through buy-back scheme. The company is thus directly benefited by the economic advantage of discontinuing the service to old machines. Instead of disposing these collected returns, the company uses these for their remanufacturing. Price of remanufactured photocopiers is generally 30% of the new ones and their quality is 'as-good-as-new'. This has created sufficient demand for these units in Indian market. Photocopy shops, small business centres, etc. are the regular customers of this remanufactured product. Having been engaged in remanufacturing for the last seven years, the company has found this an economically viable business proposition.

Remanufacturing process and relevant issues

This section deals with detailed discussion of the remanufacturing process of the company. Issues relating to the different activities are studied and the critical ones are identified.

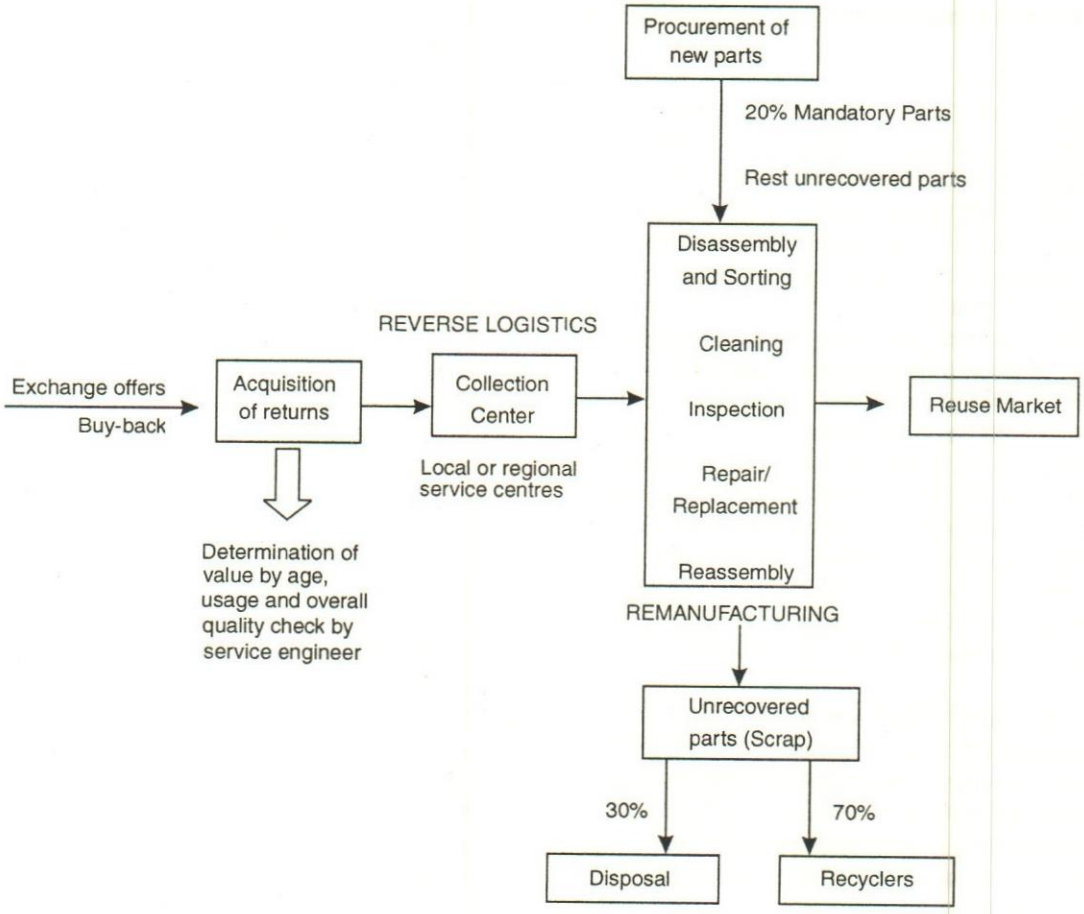

Fig. 1. The remanufacturng system of the company.

The remanufacturing process of the company starts with the acquisition of returns from the market. The acquisition is planned on the basis of the updated information about the used products collected from the service centres of the manufacturing unit. The returns are bought back by the company from the customers or are replaced by new models through exchange offer schemes. After some overall quality check by service engineer, the returns are approved for purchasing. The acquired returns are then transported to the remanufacturing site. These are initially stored as an inventory and are just meant for remanufacturing purpose only. At the remanufacturing plant, the returns are then disassembled, cleaned, sorted, inspected and repaired (if necessary). Subsequently, they are reassembled to build up a remanufactured product whose quality is 'as-good-as-new'. The parts/components which cannot be recovered from the returned unit are procured from outside during the reassembly process. The unused or discarded parts/components are sold as scrap to the recyclers. Finally, the remanufactured product is sold to the market with a specific model name and at a price lower than the new product. The Figure 1 depicts the pictorial representation of all the relevant activities as practiced by the company.

A structured questionnaire is prepared listing down all possible issues collected from the literature survey (as mentioned in the second section) and then the management of the company is asked to rate these issues according to their importance on the scale of 0-5 (where, 0 represents 'not important'; 1 – 'least important'; 2 – 'somewhat important'; 3 – 'important'; 4 – 'very important'; 5 – 'most important'). These ratings are nothing but the perceptions expressed by the company's management personnel. The important and the critical issues are subsequently identified and finally, analysis of these issues gives rise to a set of research questions, which represents prospective areas for future research.

Remanufacturing process of the company is broadly classified into the following set of activities. It may be noted here that inventory management is being considered as an activity, not included in reverse logistics. Reverse logistics here includes the activities relating to collection

of returns and reverse distribution.

(i) Returns Acquisition
(ii) Reverse Logistics
(iii) Inventory Management
(iv) Remanufacturing operations
(v) Sales and Marketing

Returns Acquisition

The customer service division of the company is efficient enough to maintain information base related to the installed machines in the market. Free servicing policy (as mentioned earlier) helps updating it. Acquisition of the returns is made involving the service centres of the company, which are meant for servicing the products. Since the company has the database of its customers, who are the primary source of returns, the problem of locating the returns is almost non-existent. Incidentally, this is normally considered to be an important decision area in managing any remanufacturing business. The returns are bought back by this remanufacturing company from the customers or are replaced by new models through exchange offer schemes at some cost termed as buy-back price. Once the overall quality check is made by the service engineer, the follow-up operation for acquisition is initiated. This quality check is nothing but to ensure the suitability of the returns for remanufacturing. In other words, inspection is done to check whether the used product has some minimal amount of recovery. However, the quantity of acquisition is obviously limited to the production capacity of the remanufacturing plant.

Following key issues are considered to be important in this acquisition process.

- The profit margin from the remanufacturing business is basically controlled by the available value of the returns at the time of acquisition. The company decides the buy-back price on the basis of (*i*) age, (*ii*) usage (number of pages photocopied, from the meter reading), and (*iii*) the quality of the used product as decided by the service engineer during inspection.
- Decision is taken on the appropriate age of the photocopier for its buying back. This is because of the fact that the age of a unit influences the recovery rate, which in turn affects the various cost parameters of remanufacturing. The best buy-back age of a photocopier is the time period when the maximum economic benefit is expected from remanufacturing (Mondal et al., 2006a).

Reverse Logistics

The company uses its forward logistics chain for the reverse distribution or collection of returns. The company has 12 regional service centres spread over the country and various local centres have been established in almost all district headquarters and major towns. With the help of such a well-designed network, the company is capable of maintaining the performance records and required database for each photocopier machine. Returns are collected through these service centres and are brought to the local and regional centres. When sufficient number of returns are accrued in that area, they are then transported (in batches) to the remanufacturing plant. The company itself manages the return acquisition and the reverse logistics process, other than the transportation operation, which has been outsourced to third party transporters. The reverse logistics network of the company takes care of two main activities – collection of returns and their transportation to the remanufacturing site.

The issues that are considered to be vital in the reverse distribution process are given in Table 2, according to their importance. From the table, it is observed that shape and size of returns, fragility of parts and planning for return flow are considered to be important issues in the reverse logistics. The first two issues focus on suitable industrial packaging and handling methods for the returns. The company is currently using wooden boxes for packing the returns. These boxes ensure sufficient protection to the returns and can be safely transported. The importance of the third issue justifies the role of an efficient return acquisition and reverse logistics system that would ensure sufficient flow of returns to the remanufacturing site. Thus, from the above discussion, two key decision areas are ultimately identified – one is on the return acquisition system and the other on reverse logistics design and logistics planning.

Table 2: Issues in reverse distribution process

Sl. No.	Issues	Importance (Scale 0-5)
1	Size and Shape of products	3
2	Fragility of parts	3
3	Planning for return flow	3
4	Special tools required	2

Inventory Management

The returns transported to the remanufacturing site are first kept temporarily in a storage area (hardly for

2-3 days). They are then disassembled, sorted, cleaned and inspected and finally stored as inventory of parts/components. Special care is taken in storing the serial number specific and matching parts. Remanufactured units are built using the parts/components from this stock. There are some parts/components like fasteners, adhesives, plastic parts, gears, bushings, etc., which are not reusable. Such parts/components form the mandatory category of items (comprising 20% of the total parts), which are procured from the market. Certain components, which cannot be recovered from the returns or discarded due to poor quality, are also procured from the market. Inventory planning for the company involves the issues as listed in Table 3.

Table 3: Issues in inventory planning

Sl. No.	Issues	Importance (Scale 0-5)
1	Serial number specific parts and matching parts	4
2	Shortages of inventory	3
3	Balancing demands with returns	3
4	MRP based	3
5	Special tools required	1

The issue that is considered to be the most important one is handling of serial number specific and matching parts. The company considers MRP-based system as quite suitable for managing inventory in remanufacturing plant. But the difficulty lies in developing a MRP system considering all the relevant factors of a remanufacturing process. This is particularly due to the fact that reassembly schedule depends on the availability of recovered parts, which meet the matching and serial number restrictions. Shortage in inventory is quite common and perceived to be a serious issue. It also supports the fact that there exists sufficient demand for remanufactured products. Balancing the demand of remanufactured product with the supply of reusable returns is another vital issue to be considered in inventory planning. This is unique in remanufacturing process, as both the supply and demand are uncontrollable in this case. Thus the returns acquisition should be efficient enough to ensure the sufficient supply of recoverables. In reality, the return acquisition and inventory management are two intrinsically related sets of activities in the remanufacturing process.

Remanufacturing operations

The remanufacturing operations of the company consist of the following sequence of activities: (i) Disassembly and Sorting (ii) Cleaning, (iii) Inspection, (iv) Repair/Replacement, and (v) Reassembly.

Disassembly and Sorting

Used photocopiers are disassembled to the level of components and parts. The standard time for disassembly of a unit is 1.5 hours. The company applies PUSH strategy in the disassembly operation, which means that the returns are disassembled as and when they arrive at the remanufacturing centre. Once the parts are dissembled they are sorted and are placed in respective bins. Sorting basically requires identification of similar parts (parts of same family) and clustering them accordingly. Considerable attention is required for matching parts and retaining the serial number of specific parts/components. Table 4, displays the list of issues relating to the disassembly operation along with the perceived degree of importance as expressed by the company representatives.

Table 4: Issues in disassembly operations

Sl. No.	Issues	Importance (Scale 0-5)
1	Permanent fastening	4
2	Corrosion/Rust	4
3	Uncertain recovery rates	3
4	Homogeneity of product range	3
5	Depth of disassembly	3
6	Dirt/Oil	3
7	Complexity in product design	3
8	Availability of disassembly technology	3
9	Special tools required	2
10	Worn out fastener heads	2
11	Size of products	2
12	Disassembly sequence	1
13	Lot sizing	1

Permanent fastening and corrosion/rust seem to be the most important issues, as they make the disassembly operation slow and expensive. Further, corrosion/rust affects the recovery rate very negatively. The issues which are found to be at least 'important' (i.e., the importance rating of 3 or more) are separated out and are classified according to the various decision areas to which they belong. This is shown in Table 5.

It is further observed that uncertainty in recovery is quite vital in disassembly operation. Recovery rate is by and large decided by the working environment, product design, disassembly technology and also by the range of variations in returns model (Issue 4 in Table 4).

Table 5: Key decision areas in disassembly operations

Decision Area	Issues	Remarks
Product Design	Permanent fastening, complexity in product design	Inclusion of DFR in product design
Working Environment	Corrosion/Rust, Dirt/Oil	High variation in recovery rate
Technology - related	Availability of disassembly technology	Standardization of disassembly operation is difficult
Production planning	Depth of disassembly	Presently done to parts/components level

Cleaning

After parts are sorted they are subjected to cleaning operation, which is a time-consuming job. This operation is exclusively carried out by the contract labours (temporary workers). The standard time for cleaning operation is 5.08 hours. Two air-jet cleaning machines are employed in this process. Oil Cleaning is done for certain parts/components. Table 6 shows the various issues with their corresponding level of importance in cleaning operation.

Table 6: Issues in cleaning operations

Sl. No.	Issues	Importance (Scale 0-5)
1	Corrosion/ Rust	4
2	Dirt/Oil	4
3	Size and Shape of products	4
4	Fragility of parts	4
5	Type of material	4

Interestingly all the issues mentioned in Table 6 are considered to be very important (with scale value of 4) in cleaning operation. The first two issues reflect the high variability in working environment and the rest shows the importance of incorporating Design for Remanufacturing (DFR) concept in product design.

Inspection

The inspection procedure of the remanufacturing operations is one of the critical steps, where, unlike in the usual manufacturing process, the parts/components undergo stringent inspection and testing. The company adopts 100% inspection for the recovered parts. The average standard time for inspecting all the parts in a used product is 6.35 hours, which is also considered to be another time-consuming task. The company maintains the quality of recovered parts/components on the basis of the following Quality Plan.

Quality Standards: Recovered part should have a residual life of at least equivalent to its design life and should fit, function and fulfill the reliability criteria and safety requirements as per specifications.

Quality Plan: In-process inspection is carried out for all parts and 100% inspection for electromechanical parts involves application of the technique popularly known as 'Signature Analysis'.

Table 7 includes the listing of the key issues (with their respective degree of importance) that generally affect the inspection process. From the table, it may be observed that skill and expertise are the essential requirements in the inspection stage. Expertise and knowledge is required to identify defects, set tolerances and define specifications for used parts. Moreover, model variety of the returns needs setting up of different inspection procedures. So management takes enough care in considering this heterogeneity factor of product range, while planning the inspection activities. These issues practically dictate the reliability and efficiency of the inspection operation. It may be noted in this context that the economic efficiency of remanufacturing operations and the quality of remanufactured products largely depend on this inspection process.

Table 7: Issues in inspection process

Sl. No.	Issues	Importance (Scale 0-5)
1	Inspector's knowledge	4
2	Defining specifications	4
3	Identifying defects	4
4	Tolerances for wear	4
5	Homogeneity of product range	3
6	Special tools required	2

Repair/Replacement

On inspection, certain parts/components are separated out that may require some additional repair to bring them into working condition. The parts/components, which cannot be repaired, are replaced by procuring new ones from the market.

Reassembly

Reassembly operation in remanufacturing is almost similar to the assembly operation in the manufacturing process except the fact that, the reassembly process is carried out using a combination of recovered parts, new parts/components and the 20% mandatory parts. The complexity in reassembly planning, unlike the usual assembly operation lies on the uncertainty in recovery and matching of recovered parts with the new parts during the process of reassembly. The relevant issues in this operation are listed in Table 8 along with their level of importance as perceived by the management personnel.

Table 8: Issues in reassembly operation

Sl. No.	Issues	Importance (Scale 0-5)
1	Homogeneity of product range	4
2	Complexity in product design	4
3	Serial number specific parts	4
4	Skill of employees	4
5	Special tools required	3
6	Uncertain demand	3
7	Permanent fastening	2
8	Type of material	2

From the Table 8, it is clearly identified that the model variety, design, serial number specific and matching parts, and skill required in reassembly process are considered to be very important issues. Requirement of special tools and uncertain demand are quite logically found to be important. Uncertainty in demand exists because of the wide variation in the demand for remanufactured items. Sometimes, it is so high that the company is unable to meet the market demand and in some other times it is too low to justify the remanufacturing economically. Of course the latter is a rare case for the company. Efficient production or reassembly schedule is essential to tackle the above issues. Although past record shows existence of sufficient market demand for remanufactured products, the reassembly activities, in general, is carried out based on PULL system of production. This means, demand triggers the activities like collecting parts from the stock as per matching and serial number specification and subsequently, reassembly as per the demanded model of the remanufactured photocopier.

Disposal

The parts/components that cannot be reusable are generally discarded. They are segregated primarily under two classes – plastic and metallic parts, and finally sold to the recyclers. The materials which cannot be recycled are disposed off. The disposal laws on used products are not too stringent in India as compared to those in western world, like Europe and US. The disposal cost is almost negligible in India.

Sales and Marketing

The recovered parts are collected and used only for remanufacturing of photocopiers. They are not meant for serving the spare parts market. The company has also experienced sufficient demand for remanufactured units. Most of the customers are from small business establishments and photocopy shops. The company has clearly segmented the market according to the usage of the remanufactured photocopier, that is by copies per minute (cpm). Corporate business houses, covering particularly telecom industry, mobile companies etc. form the class of high cpm customers; medium cpm customers are educational institutes, photocopy shops, etc. and finally, the low cpm customers are the small business establishments. Since remanufactured products are cheaper than the new ones, a customer in the lower usage segment can upgrade himself to the higher usage segment utilizing this cost advantage. A remanufactured photocopier costs approximately 30% of a new product. One important element that is commonly associated with marketing is the 'green image', which attracts the environmentally conscious customers. The issues which are considered to be directly related to the sales and marketing of these remanufactured units are shown in Table 9. It may be noted that all the three issues are rated to be either 'very important' or 'important' by the executives of the company.

Table 9: Issues in sales and marketing of remanufactured products

Sl. No.	Issues	Importance (Scale 0-5)
1	Market segmentation	4
2	Cheaper price of remanufactured product	4
3	Green image as marketing element	3

Possible research directions

Various issues relevant to the remanufacturing system are studied in the previous section and the critical ones (those which are considered to be at least 'important') are identified. The critical issues or their possible combinations give rise to various areas of management concern, which demand serious study, or even critical analysis. As remanufacturing management

is yet to achieve its matured status either as an established business practice and as a field of management research, it is intended to explore directions for future research in this new field of operations management. In this pursuit, it would be quite relevant to propose the specific research areas on the basis of real life case study on an Indian photocopier remanufacturer. Table 10 depicts the list of research areas explored as a result of critical study on relevant issues relating to the management of this remanufacturing business.

Conclusion

Remanufacturing is essentially a value-additive process on used products. With the help of remanufacturing activities, useful life of a product is lengthened, a remanufacturer enjoys economic benefit, a customer gets cheaper but 'as-good-as-new' product and a country gets ecological benefit. This research report is the outcome of a critical study on an Indian company remanufacturing photocopiers. This study throws light on some new directions of future research pertaining to managing a remanufacturing process incorporating Indian business environment, being reflected by the case study. An attempt has been made to explore the relevant issues in all possible areas of remanufacturing, namely returns acquisition, logistical planning, design for remanufacturing, production planning and control etc., which primarily determine the performance of the organization and influence the strategy formulations in remanufacturing business. The critical issues identified in the study are related to some areas of decision problems. In-depth study and critical examination are quite essential for understanding, structuring and solving these problems. Following shows a list of essential decision areas which are recommended to be seriously attended by the management of any remanufacturing business house.

Table 10: Research issues by remanufacturing activity

Remanufacturing Activity	Issues	Remarks
Return Acquisition	• Value of returns on the basis of its age and usage	• Acquisition Plan (quantity of returns to be bought and the age of returns with their corresponding buy-back price)
Reverse Logistics	• Size and Shape of returns • Fragility of parts	• Packaging and handling methods for returns
	• Planning for return flow	• Designing reverse logistics network
Inventory Management	• Serial number specific parts and matching parts • Shortages in inventory • MRP-based inventory • Balancing demands with returns	• Development of suitable Inventory models incorporating unique features of remanufacturing operations
Disassembly and sorting	• Permanent fastening • Corrosion/Rust • Dirt/Oil • Uncertain recovery rate	• Design For Remanufacturing (DFR) • Managing workplace environment (User's management)
	• Homogeneity in product range • Depth of disassembly	• Production Planning
Cleaning	• Corrosion/Rust/Dirt/Oil	• Managing workplace environment (User's management)
	• Size and shape of products • Fragility of parts • Type of material	• DFR
Inspection	• Inspector's knowledge • Defining specification • Identifying defects • Tolerances for wear • Homogeneity of product range	• Skill and expertise of inspection personnel
Reassembly	• Homogeneity of product range • Serial number specific parts • Uncertain demand	• Production schedule
	• Skill and expertise • Special tools	• Skill and expertise of workers/ supervisors
	• Complex product design	• DFR
Sales and Marketing	• Identifying customers • Cheaper price and quality 'as-good-as-new'	
	• "Green Image" as marketing element	• Market Segmentation

Issues relating to remanufacturability or reusability of parts/components are to be incorporated while *designing a new photocopier.* Various technical factors, such as consideration of ease for disassembly, study of life cycles of all the modules/ components/parts, etc. should be given due care during product design for making its future remanufacturing effective and efficient.

Analysis of product life cycle helps in estimating facts like, when a used product should be collected or whether the new parts and components are available for this model in the market or not. An effective *returns acquisition planning* can only be worked out on the basis of this life cycle analysis of photocopiers.

Workplace management largely influences the recovery from a used product. Hence, standardising the workplace operation and process, and formulating appropriate strategies for reduction of uncertainty in recovery rate is one of the key decision areas, which is primarily controlled by the user of the photocopier.

An effective *Production Planning and Control* is required to decide on the depth of disassembly and handling of matching and serial number specific parts.

Appropriate *inventory model* is essential which would incorporate issues like, serial number specific and matching parts restriction, shortages in inventory due to variability in recovery and demand, MRP-based system related issues and balancing demand of remanufactured photocopiers with the availability of returns.

Logistical planning to bring returns to the remanufacturing site at a minimum cost is also one of the important decision areas under remanufacturing management.

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Feature

Small Scale Industry Performance in Uttar Pradesh: Pre and Post-Reform Scenario

Nomita P. Kumar

This paper examines the growth performance of small scale industries (SSI) in Uttar Pradesh and the recent policy shifts in the State economy, in order to see what steps need to be taken to strengthen this sector. The industrial economy of the state is dominated by small-scale industries, of which about 0.28 per cent are already sick, largely due to lack of professional management and rapid technological obsolescence. However, new vistas for the SSI sector are opening up. The need of the hour is to reinvigorate technological prowess and professional management, so as to bolster the competitive strength of SSIs.

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After much dithering and measured wariness, the UP government brought out its new Industrial and Service Sector Investment Policy, on February 19, 2004. The main focus of the new look policy is on enhancing the competitiveness of industry in the state, within the broader outlook of the ongoing reforms process. It aims to accomplish this by minimising government controls and regulations, by repealing anachronistic legislation, by introducing power sector reforms, rationalising tax administration to make it more industry-friendly, minimising the role of the government in direct manufacturing sectors through disinvestments in PSUs, and above all, by scafolding and reinforcing industrial infrastructure in the state. It is argued that by improving competitiveness through cost reduction and quality enhancement of production, industry can achieve a level playing field under the WTO regime, enabling it to take on foreign competition sportingly.

Small industries in India have been confronted with an increasingly competitive environment due to the liberalization of the investment regime favouring foreign direct investment, the formation of WTO in 1995, forcing its member countries to drastically scale down quantitative restrictions on imports and domestic economic reforms (Bala Subrahmanya, 2002). The cumulative effect of these developments is a remarkable transition of economic environment in which small industry operates, implying that the sector has no option but to 'compete or perish' (Bala Subrahmanya, 2004). The policy-makers are seized of the fact that industrial growth in the state has stagnated over the years, and has in fact decelerated from over 14.2 per cent per annum in 1994-95, to around 5.62 per cent in 2002. During the 9th Plan, it grew by just 6.2 per cent. The share of manufacturing in the state's domestic product has hovered around 14 per cent. The state's industry is predominantly small-scale, at over 90 per cent, churning out low value-added goods with low efficiency and productivity. In fact, the SSI sector has

been expected to play a crucial role in the industrial development of the State. Indeed, the growth of industries in this sector has been a dominant feature of development of our State's economy.

The objective of this paper is to examine the growth performance of the SSI in Uttar Pradesh and try to examine the recent policy shifts in the State economy - its implications and what steps need to be taken to strengthen small industry to ensure its sustained contribution to the economy. However, to get a proper perspective and for better appreciation, we look at the record of the SSI sector at the state levels. Since non-availability of data on a regular basis restricts the scope of any kind of study on the SSI sector, we describe, in the next section, the organisational structure and the principal sources of data on this sector and point out the limitations and gaps in such data.

Organisational Structure and Data Sources

Availability of complete information on the SSI sector over a period of time is crucial for examining the structure, growth and performance of the sector and for formulating appropriate policies on the sector. As far as data availability is concerned there are two major national sources of information on small scale industries in India: the Small Scale Industry Development Organisation (SIDO) and the Central Statistical Organisation. Each has its own strength and weaknesses. Although representing a substantial share of the total SSI population, SIDO does not cover all industries. More importantly its data suffer from sampling problems and are highly aggregated. On the other hand, CSO provides better coverage and is less aggregated, but its information is scattered among different surveys and is not readily available.

Administratively the Indian SSI is divided into seven industry groups:-

- handicrafts
- handlooms
- khadi, village and cottage industries
- coir
- sericulture
- powerlooms, and
- small-scale industries that are residual

The first five sub-sectors are collectively called the "traditional" sector whereas the last two - powerlooms and residual small scale industries - are known as the "modern" sector. Each of the sub-sectors has its own supervisory body or board, such as Khadi and Village Industries Commission, Development Commissioner for Handlooms, Development Commissioner for Handicraft Board, Central Silk Board, Coir Board and SIDO. The residual "small scale industries" sub-sector is overseen by SIDO. Because it accounts for the important share of SSI, SIDO is often seen as representing the whole sector (Saluja, 2005). The Small Industries Development Organisation (SIDO) under the development commissioner, SSIs, is responsible for maintaining the database of statistical information pertaining to the SSI units falling in its purview and also for devising policies for the development of the SSI sector which are implemented by the state governments.

A significant proportion of the SSI units are, however, found amongst the registered manufacturing, which constitutes part of the ASI. Two important points to be noted for the SSI sector in this context are (i) as opposed to the factory sector, the SSI, which constitutes a very large segment of the industrial sector in India, is defined in terms of capital invested in plant and machinery and not according to employment size, and such frequent revision had affected the scope of SSI units and consequently the comparability of data on SSI for different years; hence there positively is an overlap between the factory sector units and the SSI units; those registered factories which invest less than the amount specified for a unit to be treated as small-scale belong to both the groups; and (ii) there is no system of compulsory registration of the units in the SSI sector and the units are not required to supply operational details. In other words, there is a scheme of registration of SSI units with the State Directorate of Industries (SDIs), but since the registration is voluntary, a considerable proportion of unit remains unregistered. There is no authentic estimate regarding the number of SSI units which are operating but are not registered with the SDI. One suspects that this number is greater than that on the rolls of the SDI (Mukherjee, Das and Bhattacharya, 1999).

Against this background, if one looks at other sources of data for this sector one finds three All-India censuses of small-scale units – the first conducted during 1973-74 with 1972 as the reference year, and the second carried out in 1990 with the reference year as 1987-88. There have been two follow-up surveys in 1982-83 and 1994-95. The main problem with these is that they cover only those units which are registered (voluntarily) with the SDI. There are huge numbers of unregistered units which remain uncovered by these censuses and one does not really know much about such a vital part of the industrial sector of our country. There is currently a third census in

the row in 2002-03 with 2000-01 as the reference year and the best part of this effort is that it has focused its attention on unregistered unit on sample survey basis and provides a complete picture of the SSI sector. Unfortunately, the information presented in the published reports of these censuses is not uniform and one cannot make comparisons over time (Mukherjee, Das and Bhattacharya, 1999).

The present study concentrates only on Uttar Pradesh – and tries to look at the growth of the SSI in the state in terms of both the number of units and employment. To start with, we look at the situation at the state level in respect of the number of units on the basis of the limited data that were available. For Uttar Pradesh, we have used the data from the *different Censuses of Uttar Pradesh as* published by the State Directorate of Industries, Government of Uttar Pradesh - the Report gives information on the number of units and employment.

Overview of Industrial Activity in Uttar Pradesh

Given the growing importance of the manufacturing sector, both for a higher overall growth and more remunerative employment generation in the economy, a closer look at some salient features of the past growth in this sector may be useful. In the first 23 years of planning, from 1951 to 1974, growth in the manufacturing sector was nearly insignificant. It was 2.3 per cent per annum in the First Five Year Plan, 1.7 per cent in Second Five Year Plan, a little higher at 5.6 per cent in the Third Five Year Plan, 1.2 per cent in three Annual Plans (1966-69) and 3.4 per cent in the Fourth Five Year Plan. The industrial scenario in the state did not undergo a significant change in this period. However, the situation changed thereafter. The growth rate picked up to a reasonable level of 9.4 per cent per annum in the Fifth Five Year Plan (1974-79). The growth rate stayed at 9.4 per cent in the Sixth Five Year Plan and went up still higher to 10.9 per annum in the Seventh Five Year Plan (1985-90). The period from 1973-74 to 1989-90 was the best period from the point of view of industrial growth in the State. Industrial growth fell down to 1.1 per cent in the two Annual Plans (1990-92) and to 4.2 per cent in the Eighth Five Year Plan (1992-97).

The growth in the Ninth Five Year Plan (1997-2002) also did not show sign of improvement. Targeted growth rate for the Tenth Five Year Plan is 12 per cent. During the period from 1994-95 to 2004-05 the manufacturing sector grew at the rate of 3 per cent. According to the Annual Plan 2006-07 of Uttar Pradesh, a growth rate of 10 to 12 per cent per annum in the manufacturing sector is the minimum, which this State must achieve in the coming years for a higher sustained overall growth and employment generation.

Industrial policies relating to the SSI sector in India were hitherto largely based on policy measures of a protective nature, such as reservation, fiscal concessions and preferential procurement of SSI products by the government. The SSI sector contributes a major share to exports and the total value added in GDP. There has been a structural relationship between the SSI sector's growth and the growth of industry and the overall economy. The performance of the overall industry, manufacturing and SSI sector is given in the Table 1. It is pertinent to correlate the overall growth of the industry sector with that of the SSI sector to understand the growth pattern in the past and workout the impact of reforms on performance of various manufacturing activities.

Though India launched economic reforms in the early 1990s, reform measures at the states were slow in forthcoming and it cannot be said that even today all the states are at the same wave length in implementing new economic policies. To make the comparison more meaningful the two periods taken are the pre and post-liberalization period. The period 1990-91 to 1997-98 is taken as the pre-liberalization and period 1998-99 to recent available data is taken as the post-liberalization period. These two periods sharply differ from each other in terms of liberalization policies that were initiated vigorously from 1991 onwards in the State of Uttar Pradesh after the declaration of industrial policy in 1998. In general, reforms at the state-level gained momentum during the second half of the 1990s which continued in the early years of the current decade (Jeromi, 2005).

It is apparent from table 1 that in the pre-reform period the SSI sector's growth was above the manufacturing sector's growth but after the implementation of liberalization policy its growth is lagging behind the growth attained by the manufacturing as well as total industrial sectors growth. It is here the State Government needs reformulation of its policies and evaluation of the reasons behind declining competencies of the SSI sector in Uttar Pradesh. It is observed that after the major policy shifts in the 1998 policy of the State government what we find is that there was higher growth only in the year 1999-00 i.e. 6.90 per cent and thereafter it showed negative as well as lower trends.

Globalization and SSI Performance in Uttar Pradesh

The total number of industries in UP is approximately

Table 1: Growth Rates of SSI Sector and Total Industrial Sector in U.P.

(1994-1995 to 2004-2005)

Year	SDP	SSI Sector Growth Rate	Manu-facturing Growth Rate	Total Industrial Sector Growth Rate
1994-95	5.79	–81.61	19.84	7.50
1995-96	3.69	391.08	3.50	3.64
1996-97	10.74	1.78	21.10	12.14
1997-98	–0.09	1.58	–4.21	–0.70
1998-99	2.75	–1.62	–2.52	2.02
1999-00	5.49	6.90	0.62	4.85
2000-01	0.99	–3.69	–2.35	0.56
2001-02	2.96	–5.73	1.54	2.79
2002-03	5.75	3.81	8.60	6.10
2003-04	4.59	0.31	4.83	4.61
2004-05	4.81	–0.17	5.76	4.93

Source: EPW Research Foundation, Census of SSI, Uttar Pradesh.

5.23 lakhs, out of which about 5.21 lakhs are of a small size, meaning thereby that only about 1,552 big and medium size industries are present in the vast state of Uttar Pradesh. The overall performance and contribution of small industries to the state economy is generally described in terms of its absolute growth in units, employment, production and investment. Equally important is its relative contribution, which can be gauged in terms of the small industry share in the state income and total employment. Thus the growth performance of small industry can be evaluated in two ways:

1. To compare the growth of units, employment, output and investment of small industry in the early 1990s with that of the late 1990s and early millenium.
2. To ascertain the small industry's relative contribution in different employment and investment slabs as well as inter-industry shifts.

This will perhaps reveal the manner in which the sector is behaving in lieu of the challenges and changes in the intensifying competitive environment emerging since the launch of the liberalization era. The growth of the small industry in terms of units, employment, production and fixed investment is estimated based on the figures as obtained by the State Directorate of Industries, Government of Uttar Pradesh.

The growth rates of small industry in terms of units, employment, output and investment for the pre-reform and post-reform era are presented in Table 2. It is clear that the growth of small industry in the pre-reform period of the early nineties has come down in terms of employment but showed a positive trend in terms of units, investment and output. But when the picture is drawn for the post-reform era, there we find that the negative trend is observed for units, fixed investment and production, except the employment scenario. The overall growth trends depict that both the number of units, employment and production indulge in negative growth, though investment showed signs of positive growth. This could be the indication that increasing competition in the globalization era does adversely affect the growth of small-scale industry in Uttar Pradesh.

Table 2: SSI Performance in Uttar Pradesh

Year	No. of units	Employment	Fixed investment (Rs. Million)	Production (Rs. Million)
1990-91	30248	148968	153.47	258.12
1991-92	33048	137647	208.48	347.11
1992-93	32807	117240	206.5	448.99
1993-94	32808	112652	205.01	484.24
1994-95	6033	28229	104.54	321.94
1995-96	29627	81453	249.9	512.16
1996-97	30155	95001	266.31	581.61
1997-98	30630	80132	403.89	1212.41
1998-99	30134	74347	399.41	1436.92
1999-2000	32212	76671	370.25	1373.62
2000-01	31023	78901	306.38	675.56
2001-02	29246	97155	270	635.04
2002-03	30361	112802	272.2	620.32
2003-04	30454	117564	276.06	383
2004-05	30402	121102	284.34	431.25
2005-06 (till Dec 05)	23224	93813	174.72	224.21
Pre-Reform (CAGR)	0.18	–8.48	14.82	24.73
Post Reform (CAGR)	–3.65	3.38	–11.14	–23.31
Overall Growth (CAGR)	–1.75	-3.04	0.87	–0.93

Source: State Directorate of Industries

To further probe the influence of globalization on the growth of small industry units, employment, production and investment, linear least square lines have been fitted based on the time series for the annual growth rates of these four variables for two periods of time 1990-91 to 1997-98 (transitional phase) and 1998-99 to 2005-06

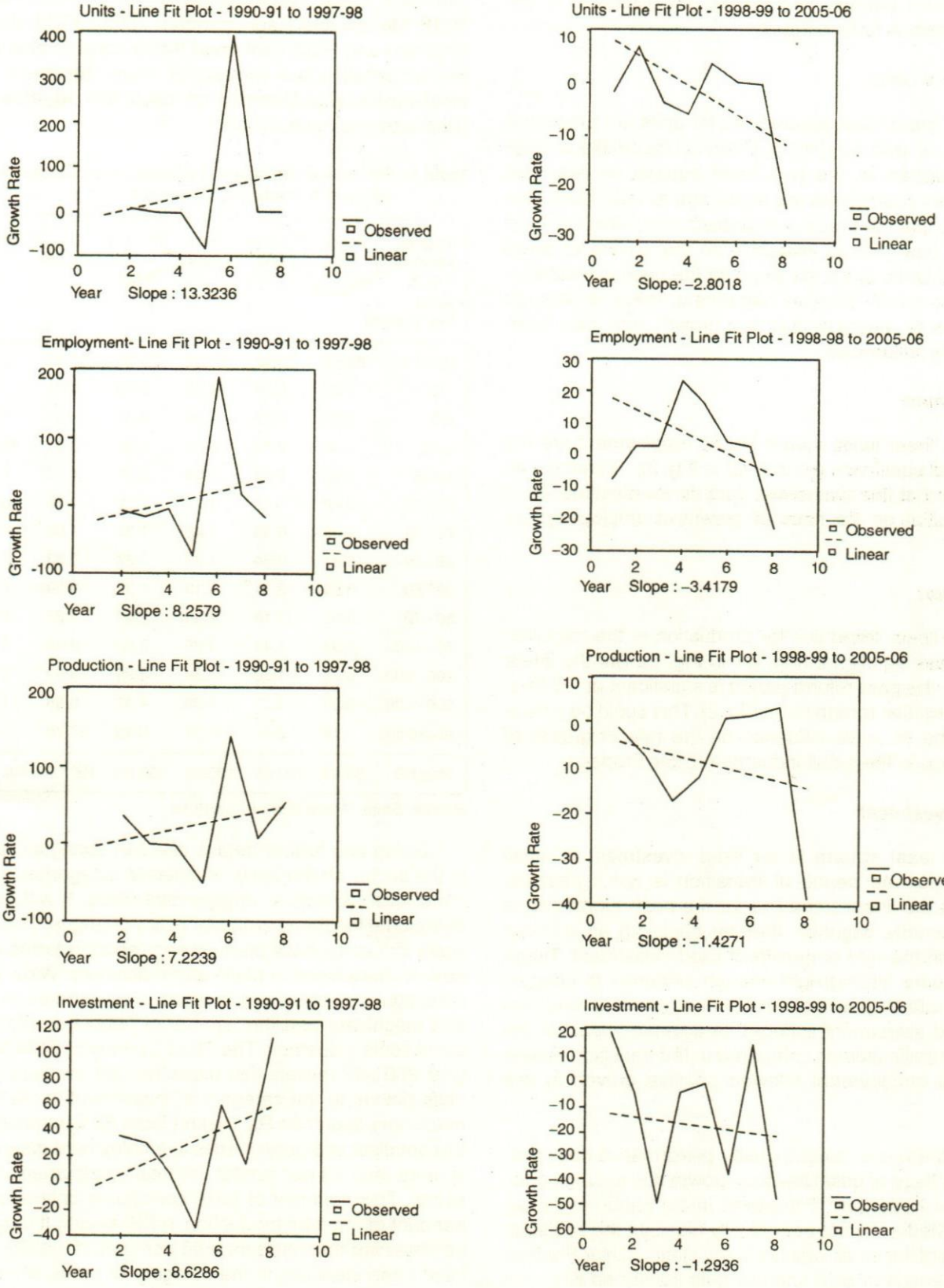

Fig. 2. Influence of Globalisation on Units, Employment, Production and Fixed Investment in Uttar Pradesh

(post-reform period). The results are displayed in the graphs from A to D in Fig. 2.

Number of Units

The linear least square lines for units are presented in graph A1 and A2 (Fig. 2).There is discernible change in the slopes of the two least square curves. The correlation coefficients are significant at .063 level. This indicates that the process of globalization, which took off in 1991 has had an influence on the growth of small industrial units. Since the slope for the post-globalization period is much steeper negatively, there is enough evidence to suggest that the growth rate has been adversely influenced.

Employment

The linear least square fits for employment are not good and significant (B1 and B2 in Fig. 2). Therefore, we can infer that the time-series data do reveal influence of globalization on the rates of growth of employment as well.

Production

The linear trend line for production in the transition phase was significant (Fig. C1 in Fig. 2). But the linear trend for the post-reform period is significant at .05 level and is negative (graph C2 in Fig. 2). This could be indicative of the negative influence on the rate of growth of production in the small industry in Uttar Pradesh.

Fixed Investment

The least square fit for fixed investment in small industry for the period of transition is not significant, whereas the linear trend line for the post-reform period is significantly negative, thereby depicting an adverse impact on the rate of growth of fixed investment. These least square fits highlight enough evidence to suggest that the rate of growth of small industry units, production and fixed investment suffered an adverse impact in the era of liberalization as compared to the transition phase, whereas employment showed positive growth in this period.

On the whole, small industry performance does indicate the issue of unsatisfactory growth due to tough challenge for its survival and growth in the period of globalization. Media reports periodically highlight the sad state of affairs of the small industry in the state of Uttar Pradesh (Third Census of SSI) and this gets confirmed after one observes the increasing sickness in this sector. Similar are the experiences of different states like Karnataka (Ramesh, 1999; Kulkarni and Parishwad, 2001; Raghu, 2001; Menon and Raghunandan, 2003). Field visits to Dharwad and Hubli confirmed that a considerable number of small scale industries have curtailed their operations significantly or resorted to closures (Balasubramanyam, 2004).

Table 3: Percentage distribution of principal characteristics by original plant & machinery value slabs

Orignal Value of P & M slabs (Rs. in lakh)	No of units	Employ-ment	Fixed capital	Original value P&M	Gross output	Export
Up to 1	89.53	73.99	51.26	56.35	37.12	31.54
1-2	3.08	4.54	4.73	3.83	4.84	0.64
2-5	2.57	4.17	4.61	4.03	3.61	1.77
5-10	1.45	2.73	3.11	3.05	3.04	16.40
10-15	0.59	1.38	2.09	2.04	1.20	0.20
15 - 20	0.42	1.17	1.73	1.77	1.33	0.18
20 - 25	0.28	0.90	1.43	1.33	1.05	0.16
25 - 30	0.21	0.64	1.29	1.27	0.83	0.17
30 - 50	0.55	2.11	4.13	4.30	3.39	0.35
50 - 70	0.31	1.16	2.30	2.49	1.85	0.54
70 - 100	0.34	1.43	3.65	2.99	2.99	1.09
100 - 200	0.28	1.50	4.34	3.95	3.99	2.81
200 - 500	0.23	1.73	5.03	4.42	6.95	11.96
Above 500	0.16	2.54	10.31	8.19	27.79	32.22
Total UP	100.00	100.00	100.00	100.00	100.00	100.00

Source: State Directorate of Industries

Going into further details one can configure growth in the sector on the basis of different categories, investment level as well as employment slabs. It will help to demarcate the thrust areas for policy changes. The small scale industries have been distinguished in terms of the size of investment in plant and machinery. Wide variations could be observed in terms of investment in plant and machinery and the number of people employed in small scale industries. The Third Census of SSIs for the year 2001-02 reveals that more than 89 per cent of the units belong to the category of investment in plant and machinery less than Rs 1 lakh (Table 3). Contribution of this smallest category of units in employment generation is more than 73 per cent of the total employment on the sector. This segment of units constitutes only about 38 per cent of the total production in SSI sector. It may also be observed that more than 96 per cent of the SSI units have been identified in the category of those where the investment in plant and machinery are less than 10 lakh. They together employ about 87 per cent of workers and

produce about 50 per cent of the total production. A striking feature of the inter-sectoral comparison is that the number of enterprises in the category of investment in plant and machinery above Rs 10 lakhs is only around 10 per cent of the total number of units, whereas they employ around 13 per cent of workers and account for as high as 37 per cent of fixed investment. They contribute more than 50 per cent of total production in the SSI sector. The contrasting figures from various categories of units suggest that the enterprises with higher investment in plant and machinery are more efficient in resource utilization as compared to their lower size counterparts. But in the absence of working capital expenditure and net value added figures for different categories of units it becomes difficult to establish conclusively this point (NPC Research Division, 1995).

Another comparison could be attempted on the number of persons employed in various units (Table 4). Nearly 93.66 per cent of SIDO units employ less than 7 workers and 97 per cent of units employ workers less than 10 persons in their units. These units also account for about 76 per cent of the total employment and fixed investment amounting to about 50 per cent, whereas contributing only about 40 per cent of total production. At the upper rung of the ladder are the units employing more than 100 persons but they are only a marginal segment of the SSI sector i.e. only 0.11 per cent. They employ only 5.93 per cent of persons and have 7.27 per cent of fixed investment. These units contribute about 12 per cent of total production in the SSI sector and contribute significantly to the exports i.e. about 34 per cent.

Table 4: Characteristics by Employment Slabs

—Emp. slab/ characteristic	No. of Units	Employ-ment	Fixed capital	P & M	Gross output	Export
1	18.05	5.05	2.69	4.35	1.37	0.01
2 to 7	75.61	62.15	31.30	35.65	22.54	5.88
8 to 10	3.34	8.15	15.50	14.63	12.85	6.57
11 to 20	1.92	7.85	18.47	17.77	23.14	14.29
21 - 50	0.78	6.97	17.75	15.15	19.80	24.11
51 - 100	0.19	3.90	7.02	5.42	9.01	15.22
Above 100	0.11	5.93	7.27	7.03	11.28	33.92
Total U.P.	100.00	100.00	100.00	100.00	100.00	100.00

Source: State Directorate of Industries

Industry-wise Performance

The major objective of promoting small scale industries has been rooted in the idea to develop a widespread

Table 5: Industrywise Performance of SSI in Uttar Pradesh (Up to March, 2005)

NIC Group	Industries	No. of Units	% Share	Investment (Rs. in Crore)	% Share	Employment	% Share
20-21	Food Products	72830	13.96	956.91	18.65	278720	13.93
22	Beverages,Tobacco & Tobacco Products	1792	0.34	28.52	0.56	9770	0.49
23	Cotton Textiles	11692	2.24	122.91	2.40	51635	2.58
24	Wool,Silk & Synthetic Fibre Textile	10673	2.05	87.35	1.70	41982	2.10
25	Jute, Hemp & Mesta Textiles	2585	0.50	19.09	0.37	10203	0.51
26	Hoisery & Garments	55502	10.64	351.72	6.86	210455	10.52
27	Wood Products	33877	6.49	222.06	4.33	117532	5.87
28	Paper Products & Printing	11214	2.15	190.96	3.72	50483	2.52
29	Leather Products	20089	3.85	179.38	3.50	89641	4.48
30	Rubber & Plastic Products	9429	1.81	290.31	5.66	50371	2.52
31	Chemical & Chemical Products	11672	2.24	333.11	6.49	60652	3.03
32	Non-Metallic Mineral Products	10502	2.01	169.22	3.30	95014	4.75
33	Basic Metal Industries	5928	1.14	159.09	3.10	33022	1.65
34	Metal Products	31303	6.00	400.05	7.80	141628	7.08
35	Machinery & Part Except Electrical	12542	2.40	259.87	5.06	58348	2.92
36	Electrical Machinery & Apparatus	8630	1.65	155.15	3.02	40353	2.02
37	Transport Equipments & Parts	3322	0.64	121.55	2.37	21060	1.05
38	Miscellaneous MFG.	71838	13.77	499.03	9.73	248542	12.42
96-97	Repairing & Servicing Industries	136415	26.14	584.54	11.39	391238	19.56
	Grand Total	521835	100.00	5130.82	100.00	2000649	100.00

Source: Same as in Table 1.

entrepreneurial base across various industries. Industry-wise contributions in terms of the number of units, employment creation and investment have been analysed in Table 5. The number of units can be understood to be a good indictor to represent the entrepreneurial base in a particular industry. The prominent industry groups in this category are repair services, food products, miscellaneous manufacturing, hosiery and garments, metal products, wood products and machinery parts, as these industries together account for over 75 per cent share to the total units in the SSI sector.

In case of employment it can be observed that the maximum employment has been generated in repair and services, food products, miscellaneous manufacturing, hosiery and garments and metal products. These five industry groups account for the maximum employment i.e. 61 per cent of the total employment generated in the SSI sector.

Another variable which has been taken up for analyzing the performance of different industry is the level of fixed investment. It may be noted that the major contributors have been food products, repair services, miscellaneous manufacturing, metal products, chemical products and hosiery and garments manufacturing in Uttar Pradesh.

Table 6 shows the growth rate of units, investment and employment in different industries over the period 2001-05. The compound annual growth of units showed that units in the category of repair services increased at the rate of 6.66 per cent followed by miscellaneous manufacturing, electrical machinery and apparatus, leather products and jute, hemp and mesta textile. Similarly, investment increased to the tune of 7.77 in repair services, followed by miscellaneous, electrical machinery and apparatus and leather products industry group. On the other hand, while analyzing the employment trend we find that it increased maximum in repair services, followed by miscellaneous manufacturing, food products, hosiery and garments and wool, fibre and synthetic textile category. Overall, the number of units increased at the rate of 4.58 per cent, investment at the rate of 4.47 per cent and employment generated was to the tune of 4.90 per cent during the period 2001-05 - after the implementation of the policy reforms by the state government.

Industrial Policy and the State's Role

The reforms at the State level have been rather slow-moving. There are several reasons. First, limited decentralisation of decision-making has meant that the States lack the authority to formulate and implement policies which are under the control of the Centre. Second, unlike the Centre, the State Governments do not have sufficient institutional back-up. Third, due to the short-terms of office that the State Governments have been holding, they are governed by short-term political considerations. Chief Ministers have changed frequently, thereby leading to policy discontinuity (since 1967, Chief Ministers, on an average, have been in office for only 2.65 years). For instance, Uttar Pradesh has seen 27 Governments in 44 years. Fourth, populist policies have always been preferred to harsh reform measures (Bajpai and Sach, 2000).

Table 6: Industrywise Growth of SSI in Uttar Pradesh - 2001-05 (%)

NIC Group	Industries	No. of Units	Investment	Employment
20-21	Food Products	4.25	6.08	4.90
22	Beverages,Tobacco & Tobacco Products	–3.03	1.33	0.03
23	Cotton Textiles	1.38	2.12	1.17
24	Wool,Silk & Synthetic Fibre Textile	4.33	3.28	4.79
25	Jute, Hemp & Mesta Textiles	5.45	4.21	4.65
26	Hoisery & Garments	4.23	6.57	4.97
27	Wood Products	3.63	2.81	4.30
28	Paper Products & Printing	3.25	3.80	3.03
29	Leather Products	5.06	6.92	4.81
30	Rubber & Plastic Products	1.69	2.30	1.94
31	Chemical & Chemical Products	2.33	2.23	1.40
32	Non-Metallic Mineral Products	1.48	0.64	0.52
33	Basic Metal Industries	3.80	0.59	2.90
34	Metal Products	1.60	3.06	2.12
35	Machinery & Part Except Electrical	2.87	2.37	3.10
36	Electrical Machinery & Apparatus	5.77	3.54	4.42
37	Transport Equipments & Parts	3.74	2.06	2.46
38	Miscellaneous MFG.	5.80	6.82	7.58
96-97	Repairing & Servicing Industries	6.66	7.77	8.60

Source: Based on Table

In Uttar Pradesh reform measures in the industrial sector started with the announcement of the Industrial Policy, 1998. The policy aims at accelerating industrial growth by attracting a steady stream of investment by creating a congenial investment climate. As 90 per cent of the industrial sector is made up of small scale indus-

tries the major policy shifts in the State's policy are directed towards this sector only. Emphasis is placed on attracting private investment in software, hardware and telecommunications. The private sector would be encouraged to set up technology parks and other infrastructure. It offers a varying investment subsidy, depending upon the amount of investment and employment generation, and other incentives. One of the major exercises undertaken recently (in 2004 policy) is to synchronize the prevailing policy framework with contemporary international economic thinking. The government has, in the recent past, announced New Industrial Development and Service Sector Investment Policy - 2004.

The Industrial policy so declared pointed towards the implementation of Single Table System, development of seven Industrial Corridors, Regular Supply of Power to the Export Oriented Units, Abolition of Inspector Raj, Rehabilitation of SSI units, Technology Mission, Increase of Employment from 8% to 15% in Industrial Sector, Increase of Industrial Contribution in Gross Domestic Production from 20 to 25 per cent, Suspension of Trade Tax Chaukis, Creation of Road Development Fund and Authorisation to Industrial Units for selling the electricity direct etc. All possible measures were taken to put industrial policy into practice and it is worthwhile to mention that the achievement of 97% under single table system is indicative of successful implementation of the industrial policy.

With this objective in mind the entire tax system is being made more and more progressive to ensure greater profitability for entrepreneurs. Rules, procedures and practices are being liberalised to bring them at par with the best anywhere, not only in India, but elsewhere also. Since the advent of liberalisation in August 1991, Uttar Pradesh has consistently attracted the third highest number of proposals for investments. Even in terms of size of proposed investments, Uttar Pradesh has continued to be the third most attractive destination in India.

Uttar Pradesh has the largest rail length in India, the second longest road length, largest number of post offices, largest number of bank branches and the second highest installed capacity of power generation. The State has 26 engineering colleges and No Objection Certificates have been issued to another 18 proposed private colleges. There are 71 polytechnics and 202 Industrial Training Institutes spread all over the State imparting training to thousands of industrial workers and supervisors. These institutes together generate a huge stock of technically skilled manpower and if this workforce is properly harnessed can prove to be "stupendous engine for the technological modernization of industry in the state" (Chadha, 2003). Under the Road Policy, active role for private sector is foreseen in construction and maintenance of roads, bridges, overbridges, underbridges, expressways and highways, etc. A Road Fund of nearly Rs. 4,000 million has been set up for the first time by any State in India. A major initiative is the setting up of a Rs 100 million Infrastructure Initiative Fund, the first of its kind in any state. It will prepare pre-feasibility studies of infrastructure related major projects to facilitate the easy entry of the private sector. The fund is also expected to catalyse private participation in infrastructure development.

In the power sector, major structural changes are underway. UP was one of the first states of India to privatise distribution in Greater Noida. It has now been decided to build on this successful model and expand it to other major industrial hubs like NOIDA, Kanpur and Moradabad. Distribution rights have been offered to industry associations in industrial areas. It has set up an Independent Regulatory Commission. It has also been decided to place some of the major generating power stations, under a separate Generation Corporation, to function as profit centers. The private sector has entered the power scene in a big way. The state has signed Power Purchase Agreements (PPAs) for nearly 2,500 MW of private power. Most of these projects have a tie-up with the major power companies of the USA, Canada, UK and Germany. The State had entered into a PPA with the National Thermal Power Corporation, with the aim of making a UP power surplus state by the end of 2003. Uttar Pradesh does have a distinct advantage of a large network of institutions to support industrial development. It has 129 developed Industrial Areas and 81 Industrial Estates, extending over a total area of 38,000 acres. The unique concept of Integrated Industrial townships can be rightly called UP's contribution to industrial and urban lexicon in India. Noida and Greater Noida have emerged as remarkable models of industrial infrastructure in the country. Situated in the neighbourhood of New Delhi, they not only provide international quality industrial infrastruture, but they also have over a period of time, emerged as the most fashionable places to live in. The State has now decided to expand on the success of the Noida/ Greater Noida model and it is proposed to develop all Industrial Areas in future as Integrated Industrial Townships. Certain specific areas of the State are to be developed as Industrial Corridors. These areas are endowed with natural advantages and have attracted sizeable investments in the past. Infrastructural growth in these areas is being accelerated to develop them as areas of excellence with private sector participation.

In order to reduce the bureaucratic red tape, the State has decided to completely revamp the entire system of industrial approvals and clearances. In future, entrepreneurs of industries involving investment of up to Rs 250 million will only be required to fill in a composite form related to various departments at the District Industries Center (DIC). At the end of a pre-determined period, he will be provided all the approvals by the DIC, which will be responsible to obtain all clearances from the departments concerned on behalf of the applicant who himself will not be required to contact any department. All DICs are being computerized for the speedy exchange of information in view of the increasing importance of information technology. An outlay of Rs 140.00 lakh has been proposed for the Tenth Plan period.

For NRIs, export-oriented units with investments above Rs 250 million and electronic and food industries with investments above Rs 100 million, this Single Table Service will be provided by the State-level Udyog Bandhu, a unique semi-Government organization for industrial facilitation. The State Government has also decided to unfetter the industries from the vagaries of indiscriminate inspections. In future, no inspection of any industrial unit will be allowed without the prior approval of the District Magistrates concerned. All 100% export oriented units will be declared as public utilities to free them from the threat of flash strikes. This facility is now being extended to all industrial units which export more than 50% of their produce. A Task Force has been set up under the chairmanship of the Industrial Development Commissioner to rationalize and simplify all the industry-related procedures, practices and rules of the trade tax, pollution and labour departments.

The UP Small Scale Industries Modernisation Fund has been stressed in the Tenth Five Year Plan. It will provide capital subsidy to the tune of 15 per cent subject to a maximum of Rs 1.00 lakh against the investment made on plant and machinery required for modernisation. It will also provide interest subsidy at the rate of 4% on the loan for plant and machinery subject to a maximum of Rs 20,000 for a maximum period of five years. To provide 50 per cent with maximum of Rs 50,000 subsidy on the investment made for equipment for establishing laboratory to have an ISI mark. This facility will be admissible after having the ISI mark. To undertake the modernisation, if study is required a subsidy to the maximum tune of Rs 10,000 will be admissible if a study is undertaken by a recognised institute, by the Sanchalan Samiti of original UP Small Scale Industries Modernisation Fund Scheme. It will only be possible to provide 75 per cent, with a maximum of Rs 1.00 lakh subsidy on the payment made to the institute as fees, for having ISO. This facility will be admissible only after the grant of ISO to the unit. To provide capital subsidy to the tune of 40 per cent subject to maximum of Rs 2 lakh against the investment made on plant and machinery required for the installation of a pollution control treatment plant. This facility will only be admissible after having proper certificate from the UP Pollution Control Board regarding successful installation of treatment plant. To meet the requirement a provision of Rs 7 crore in the Tenth Five Year Plan and for 2002-2003, Rs 70 lakh is proposed.

So much so on paper, but the questions remain: Why are industries following a receding growth in Uttar Pradesh? Why is growth in the industrial sector not to the mark? Why cannot the existing unit flourish rather than close down? And why is it that industries are escaping to the State of Uttaranchal? To answer these questions one needs to pay attention for further evaluation keeping in mind the state of affairs of the economy. The policies in 1998 were not satisfactory as the growth had not triggered further growth, but instead negative trend is visible. But one has to wait for some more time to evaluate the effect of the recent policy shifts that had occurred following the New Industrial and Service Sector Investment Policy of 2004 of Uttar Pradesh.

Conclusion

The industrial economy of the state is dominated by small scale industries, of which about 0.28 per cent are already sick. The main cause of their sickness has been lack of professional management and rapid technological obsolescence. This has eroded their competitiveness vis-à-vis large industries. They will be at a further disadvantage in future with the progressive dereservation of items produced by the SSI sector and the continuous influx of technologically strong MNCs, as the liberalisation and globalisation of the economy progresses. However, there is no need to panic because progressive integration of the domestic economy with the global economy has also opened up new vistas for the SSI sector, as it would now have greater access to the world markets, state-of-the-art technologies and abundant finance. The need is to infuse a fresh zeal and structural modernisation of SSI units by reinvigorating their technological prowess and professional management, so as to bolster their competitive strength.

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The function of all art is an extension of the function of the visual brain to acquire knowledge; artists are, in a sense, neurologists who study the capacities of the visual brain with techniques that are unique to them.

– Semir Zeki

Feature

Problems and Prospects of Agriculture in Punjab

M.S. Sidhu, A.S. Joshi & Lavleen Kaur

Punjab agriculture, which had grown rapidly earlier, has now reached a sort of plateau in terms of productivity and production. In the wake of a declining land-man ratio, it is not able to generate gainful employment and sufficient income for the growing population. Punjab farmers are in deep economic crisis. The National Rural Employment Guarantee Scheme is a right step in the right direction. The paper is based on a study undertaken by the authors. This paper recommends that this scheme is extended to all the districts of the State over the next two to three years.

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Punjab witnessed a major breakthrough in farm production starting in the late 1960s. The increase in wheat and paddy production improved the economic status of the peasantry, bringing about an overall change. A number of factors have made this possible. These include the introduction of high yielding varieties (HYVs) particularly of wheat and paddy, assured price policy and supporting infrastructure for supply of different inputs and dissemination of the technical know how. However, the prime movers in this growth process were the farmers themselves, who were quick enough to exploit the new production possibilities. The result is that the state, with 1.53 per cent of the geographical area of the country, accounted for about 60 per cent of wheat and about 40 per cent of rice procured for the central pool of foodgrains during the last three decades or so.

Punjab agriculture, which was growing fast earlier, has now reached a sort of plateau in terms of productivity and production. In the wake of a declining land-man ratio, it is not able to generate gainful employment and sufficient income for the growing population. Farm profitability has witnessed a decline in the recent years due to cost price squeeze. There is almost stagnation in farm income. Farming alone is not able to generate sufficient income for small and marginal farmers. Due to economic distress, 2,116 farmers had committed suicide during the last 15 years in Punjab (Nibber, 2004). However, some other organizations claim that the actual figure is staggering, somewhere between 10,000 and 13,000 (HT Correspondent, 2006).

At present, the farm indebtedness is to the extent of about Rs 26,000 crore, which works out to be about Rs 2.61 lakh per farming household. The Punjab farmers are in deep economic crisis. Keeping in view of this, the present study has been undertaken to examine various problems faced by the farm sector in the state and its prospects in the future.

Results and discussion

Number of operational holdings

The information about the number of operational holdings in Punjab is given in Table 1. There were 10.27 lakh operational holdings in 1980-81. Their number increased to 11.17 lakh in 1990-91 but marginally declined to 10.93 lakh in 1995-96 but in the year 2000-01, this number sharply declined to 9.97 lakh. The maximum decline was observed in the case of marginal and small farmers. Their number was 3.86 lakh in 1995-96, which plummeted to 2.96 lakh in 2000-01. These figures reveal that agriculture is becoming unremunerative, particularly for marginal and small farmers, who are therefore forced to lease out their tiny holdings. In many cases, they also sold their land to clear their debts and to meet other social obligations.

Another phenomenon about the operational holdings in the state is with regard to the number of large farmers. Although their number was just six to seven per cent during the last two decades, they operated about 27 to 29 per cent of the area during this period. Therefore, we can say that modern farming is more favourable for large farmers as compared to marginal and small farmers. The average size of operational holding was 3.79, 3.61, 3.79 and 4.03 hectares during the years 1980-81, 1990-91, 1995-96 and 2000-01 respectively. At the national level, it is just 1.41 hectares. Therefore, the Punjab scenario is better than in other states.

It is worthwhile mentioning here that in the pre-green revolution period in the state, the bachelor farmer used to donate his share of land to his nephews (bhatijas). This prevented the land from being further divided. This was known as the Draupati system (named after the wife shared by the Pandavas princes in the Mahabharta) and there was no stigma attached to it (Mishra, 1999). Due to the spread of education and awareness among the farmers, this practice has almost disappeared from the rural Punjab during the post-revolution period.

Increase in the number of workers

The information regarding the number of agricultural workers as cultivators and agricultural workers is given in Table 2. The number of cultivators has increased from about 16 lakh in 1961 to about 21 lakh in 2001 whereas, the number of agricultural workers jumped from 3.35 lakh to 14.90 lakh in the corresponding period. The trend of sub-division of land holdings is reflected more evidently in the land operated per cultivator and agricultural worker (taken together), which has declined gradually from 1.94 hectares of net area sown in 1961 to 1.20 hectares in 2001. In terms of gross cropped area, this figure has declined from 2.44 hectares to 2.23 hectares during the same period. The facts given above are not mere statistical figures but rather have wider social, economic and political implications for the state as well as the country.

Table 2 further reveals that net area sown per

Table 1: No. of operational holdings, area operated and average size of operational holdings in Punjab

(Area in hectares)

Farm category	1980-81			1990-91			1995-96			2000-01		
	No	Area operated	Av. Size of operational holdings	No	Area operated	Av. Size of operational holdings	No	Area operated	Av. Size of operational holdings	No	Area operated	Av. Size of operational holdings
Marginal (Below 1 hect.)	197323 (19.21)	118331 (3.04)	0.60	295668 (26.47)	164130 (4.07)	0.56	203876 (18.55)	122000 (2.94)	0.60	123000 (12.34)	77000 (1.91)	0.63
Small (1-2 hect.)	199368 (19.41)	281036 (7.22)	1.41	203842 (18.25)	328261 (8.14)	1.61	183453 (16.78)	240000 (5.79)	1.31	173000 (17.35)	242000 (6.02)	1.40
Semi-medium (2-4 hect.)	287423 (27.99)	790948 (20.32)	2.75	288783 (25.86)	841621 (20.87)	2.91	320340 (29.31)	833000 (20.09)	2.60	328000 (32.90)	876000 (21.76)	2.67
Medium (4-10 hect.)	269072 (26.20)	1565548 (40.22)	5.82	261481 (23.41)	1621946 (40.22)	6.20	305794 (27.98)	1754000 (42.30)	5.74	301000 (30.19)	1731000 (43.04)	5.75
Large10 hect. & above)	73941 (7.19)	1136599 (29.20)	15.37	67172 (6.01)	1076727 (26.70)	16.03	79610 (7.28)	1198000 (28.88)	15.05	72000 (7.22)	1096000 (27.25)	15.22
All holdings	1027127 (100.00)	3892462 (100.00)	3.79	1116951 (100.00)	4032685 (100.00)	3.61	1093073 (100.00)	4147000 (100.00)	3.79	997000 (100.00)	4022000 (100.000	4.03

Note: Figures in parentheses indicate percentages to the total

Table 2: Net and gross cropped area available to the cultivators and agricultural workers in Punjab, 1961 to 2001

Year	As cultivators (No.)	As agri. workers (No)	Net sown area per cultivator (hect.)	Net area sown per agri. worker (hect.)	Gross cropped area sown per cultivator (hect.)	Gross cropped area sown per agri. worker (hect.)
1961	1602666	334610	2.34	11.23	2.95	14.14
1971	1665153	786705	2.43	5.15	3.41	7.22
1981	1767286	1092225	2.37	3.84	3.82	6.19
1991	1917210	1452828	2.20	2.90	3.91	5.16
2001	2065067	1489861	2.06	2.85	3.85	5.33

Year	Net area sown per cultivator and agri. worker (hect.)	Gross cropped area per cultivator and agri. worker (hect.)
1961	1.94	2.44
1971	1.65	2.32
1981	1.47	2.36
1991	1.25	2.23
2001	1.20	2.23

Source: Statistical Abstract of Punjab, various issues

cultivator has declined from 2.34 hectares in 1961 to 2.06 hectares in 2001. This figure for the agricultural worker was 11.23 hectares and 2.85 hectares in the corresponding period. Due to increase in cropping intensity, the gross cropped area per cultivator has increased from 2.95 hectares in 1961 to 3.85 hectares in 2001. During the last one decade, i.e. 1991 to 2001, the gross cropped area per cultivator has declined from 3.91 hectares in 1991 to 3.85 hectares in 2001. As already discussed, there has been a fast increase in the number of agricultural workers during the last four decades i.e. from 1961 to 2001. Their number was 3.35 lakh in 1961 which increased to 14.90 lakh in 2001. It had an adverse impact on the gross cropped area available to each agricultural worker. The gross cropped area per agricultural worker declined from 14.14 hectares in 1961 to 5.33 hectares in 2001. The fast mechanism of agriculture in this state has also narrowed down the employment opportunities for the agricultural labourers. A recent study has shown that use of each harvest combine eroded an estimated 24,000 person days of work in a year (Mander, 2004). Moreover, the increased use of weedicides for control of weeds in the major crops i.e. wheat and paddy, has obviated the need for human labour for inter-culture operations. The excessive use of weedicides has not only replaced the human labour but has adversely affected the soil health too.

Land use pattern

The information about land use pattern shows that the net area sown in the state was 4,224,000 hectares during the year 2002-03 out of a total reporting area of 5,033,000 hectares, which means that about 84 per cent of the reporting area was already under cultivation, which was the highest in the country. There was only a negligible area available under current fallows and other uncultivated land. The net area sown increased from 3,870,000 hectares in 1966-67 to 4,224,000 hectares in 2002-03, which means on average increase of about 10,000 hectares per annum.

On the other hand, the total cropped area increased by 2,655,000 hectares during this period which gives an average increase of about 72,000 hectares per year. It may be mentioned here that net area sown increased from 3,870,000 hectares in 1966-67 to about 4,200,000 hectares in 1980-81. After that, there has been no significant increase in net area sown in the state. It happened mainly because of the fact that size of the land is fixed and increase in area came mainly from an increase in the total cropped area. Due to an increase in the cropping intensity, the total cropped area increased from 5,171,000 hectares in 1966-67 to 7,945,000 hectares in 1998-99. After that, it has almost become constant because there is limit to increase the cropping intensity also. Therefore, there is little scope to increase cropping intensity in the near future and the total cropped area will remain constant around 7,900,000 hectares. On the other hand, there is a possibility of decline in net area sown in the state due to use of land for non-agricultural purposes. This will have an adverse effect on the total cropped area also. Above all, the forest wealth of the state is very poor as is evident from Table 3.

Table 3: Shifts in cropping pattern in Punjab, 1960-61 to 2002-03

(Area 000' hect.)

Years/crop	Wheat	Rice	Maize	Total cereals	Total pulses	Rapeseed & mustard	Total oilseeds	Cotton	Sugarcane	Potato
1960-61	1400 (29.58)	227 (4.80)	327 (6.91)	2160 (45.65)	903 (19.08)	107 (2.26)	185 (3.91)	447 (9.45)	133 (2.81)	9 (0.19)
1970-71	2299 (40.48)	390 (6.87)	555 (9.77)	3514 (61.89)	414 (7.29)	103 (1.81)	295 (5.19)	397 (6.99))	128 (2.25)	17 (0.29)
1975-76	2439 (38.99)	567 (9.06)	577 (9.22)	3891 (62.21)	441 (7.05)	122 (1.95)	315 (5.03)	580 (9.27)	114 (1.82)	27 (0.43)
1980-81	2812 (41.58)	1183 (17.49)	382 (5.65)	4513 (66.73)	341 (5.04)	136 (2.01)	238 (3.52)	649 (9.59)	71 (1.05)	40 (0.59)
1985-86	3112 (43.47)	1714 (23.95)	260 (3.63)	5169 (72.21)	225 (3.14)	151 (2.11)	211 (2.95)	559 (7.81)	78 (1.09)	43 (0.60)
1990-91	3273 (43.63)	2015 (26.86)	188 (2.51)	5525 (73.65)	143 (1.91)	69 (0.92)	104 (1.39)	701 (9.34)	101 (1.35)	23 (0.31)
1995-96	3221 (41.77)	2185 (28.33)	171 (2.22)	5625 (72.94)	95 (1.23)	101 (1.31)	237 (3.07)	742 (9.62)	136 (1.76)	39 (0.51)
1996-97	3229 (41.36)	2159 (27.65)	166 (2.13)	5593 (71.63)	91 (1.17)	92 (1.18)	208 (2.66)	741 (9.49)	173 (2.22)	48 (0.61)
1997-98	3300 (42.13)	2281 (29.12)	165 (2.11)	5791 (73.93)	84 (1.07)	72 (0.92)	150 (1.91)	724 (9.24)	126 (1.61)	55 (0.70)
1998-99	3278 (42.35)	2518 (32.53)	154 (1.90)	5987 (77.35)	73 (0.94)	74 (0.95)	160 (2.07)	563 (7.27)	103 (1.33)	80 (1.03)
1999-2000	3388 (43.18)	2604 (33.18)	163 (2.08)	6190 (78.88)	62 (0.79)	56 (0.71)	98 (1.25)	477 (6.08)	108 (1.38)	76 (0.97)
2000-01	3408 (42.95)	2612 (32.92)	164 (2.07)	6222 (78.41)	55 (0.69)	55 (0.69)	86 (1.08)	473 (5.96)	121 (1.52)	64 (0.81)
2001-02	3422 (43.09)	2489 (31.34)	165 (2.08)	6106 (76.89)	49 (0.62)	51 (0.64)	83 (1.05)	607 (7.64)	142 (1.79)	57 (0.72)
2002-03	3375 (43.13)	2530 (32.33)	153 (1.95)	6091 (77.83)	41 (0.52)	66 (0.84)	99 (1.26)	450 (5.75)	154 (1.97)	67 (0.86)

Note: Figures in parentheses indicate percentages to the total cropped area

Shifts in cropping pattern

The cropping pattern in the state is shown in Table 3. The figures show that during the year 2002-03, about 78 per cent of the total cropped area was under foodgrains, about 11 per cent under cash crops, i.e. cotton, sugarcane, oilseeds and potatoes. It may be stated here that about nine per cent of the total cropped area was under rabi and kharif fodder crops and about two per cent under fruits and vegetables. Wheat is the principal crop of Punjab which alone had about a 43 per cent of the cropped area followed by rice which had about a 32 per cent area. In this way, these two crops taken together occupied about 75 per cent of the area.

Rice is not a traditional crop of Punjab. The area under rice was just 227,000 hectares in 1960-61, which increased to 390,000 hectares in 1970-71, 567,000 hectares in 1980-81, 1,183,000 hectares in 1985-86 and 2,015,000 hectares in 1990-91. It reached to the level of 2,612,000 hectares in 2000-01. The major factors responsible for increase in its area are high and stable yield as compared to other kharif crops, assured price and public procurement. We can say that net returns to the farmers from paddy crop are high vis-à-vis other competing kharif crops. Paddy has replaced kharif pulses and oilseeds on a large scale in the last three decades. The area under wheat was 1,400,000 hectares in 1960-61 which increased to about 2,300,000 hectares in 1970-71, 2,812,000 hectares in 1980-81, 3,273,000 hectares in 1990-91 and about 3,400,000 hectares (from 1999-2000 to 2002-03). Wheat crop has also replaced rabi pulses particularly gram and oilseed crops. This crop has also high and stable yield as compared to other rabi crops. Moreover, the Govt. of India procures it at the minimum support price (MSP). It is also a staple food of the Punjabis. Wheat bhusa, the by-product of wheat is also used on a very large scale by the farmers to feed dairy

animals. Therefore, we can say that wheat is a natural crop of Punjab. Moreover, its irrigation requirements are not high as in case of paddy.

Maize was an important crop of the state in the pre-green revolution period. The area under maize was 327,000 hectares in 1960-61 which declined to 188,000 hectares in 1990-91. Further, it plummeted to 153,000 hectares in 2002-03. In percentage terms, the maize area declined from about seven of the cropped area in 1960-61 to about two in 2002-03. As already discussed, with the fast increase in paddy area, the maize area declined significantly. Although MSP is announced for maize crop every year but there is no effective public procurement. Therefore, to avoid price risk, the Punjab farmers particularly in the central zone has shifted from maize to paddy on a large scale in the kharif season.

The area under potato crop has also increased during the last three decades. Its area was 17,000 hectares in 1970-71 which increased to 80,000 hectares in 1988-99, but due to price fluctuation, its area has also declined to 57,000 hectares in 2001-02 but again increased to 67,000 hectares in 2002-03. Price of potato is a major factor for the increase or decrease of potato area. Generally, its market price is fixed according to the forces of demand and supply. This crop is also not covered effectively under the public procurement programme.

All this reveals that cereals, particularly wheat and paddy, have come to dominate the cropping pattern in the state in the wake of new farm technology and axe has fallen mainly on pulses and oilseeds. As already discussed, this outcome is the consequence of higher profitability of wheat and paddy cropping system. There is another dimension of this problem. Pulses and oilseeds are legumes and their cultivation was an important natural source of restoring the soil fertility. The decline in their area has resulted in reduced availability of natural sources of fertilization of soils.

There is also concern over the long range effect of cereals dominated cropping pattern particularly the rice cultivation and also overall exploitative agriculture which could have deleterious effect on the soil health. The indiscriminate and uncontrolled use of underground water may not also be desirable in several areas of the state from the long-run point of view of sustained use of this scarce and precious resource.

Over-exploitation of ground water

In the post-green revolution period, the number of tubewells for irrigation purpose had increased very fast. There were only 1973 tubewells in the state in 1950-51. This number increased to about 12,000 in 1960-61, 1.92 lakh in 1970-71, 6 lakh in 1980-81, 7.73 lakh in 1990-91, 10.73 lakh in 2000-01 and 11.68 lakh in 2004-05.

At present, about 75 per cent of the irrigation is through tubewells and the remaining 25 per cent by canals. This phenomenon resulted in the over-exploitation of ground water. Paddy is a water intensive crop. The over-exploitation of ground water is also linked mainly with the paddy crop. During the year 1984, there were only about 45 per cent over developed blocks in the state (Table 4). This number increased to about 76 per cent during the year 2004. The number of white blocks was about 31 per cent in 1984 which declined to about 12 per cent in 2004. Similarly, the share of grey blocks declined from about 19 per cent in 1984 to about six per cent in 2004.

Already due to the decline in the water table, more than one lakh tubewells have been replaced with submersible pumps and around 3.9 lakh centrifugal pumps will have to be replaced by submersible pumps in the next few years, costing crores of rupees and increasing the energy requirements three-fold to pump out the same quantity of water (Aulakh, 2004). The PAU experts always advise the farmers not to transplant paddy before 15 June because transplantation of paddy before the PAU recommendation results in fall of water table. It may be stated here that paddy transplanted on May 1 result in 70 cms decline in the water table, 60 cms in case of May 10, 50 cms on May 20, 28 cms on May 30 and 10 cms on June 10.

Keeping in view these facts, some hard policy decisions are to be taken by the State Government. For the last two decades, the PAU advice to the farmers did not have a significant impact in this regard. According to press reports, some farmers of Moonak block (Sangrur district) transplanted paddy as early as on April 20, 2006 (Sharma, 2006). In central Punjab, the water table is declining very fast, which would have wide implications in the years to come. From the years 1982-87, the water table in the central Punjab declined by 18 cms per year. This figure increased to 25 cms in the years 1992-97, 42 cms in 1997-2002, 69 cms in 2003-04 and 74 cms in 2004-05 (Govt. of Punjab, 2006).

The district-wise categorization of the water table in Punjab for the year 2004 is given in Table 5. The cent per cent blocks of Amritsar, Faridkot, Fatehgarh Sahib, Jalandahr, Kapurthala, Mansa, Moga and Sangrur were over developed, where the withdrawal of ground water was more than 100 per cent of the recharge. This figure

was about 91 per cent for Ludhiana district, 89 per cent for Patiala district, 70 per cent for Ferozepur district, 57 per cent each for Bathinda and Gurdaspur districts, 29 per cent for

Table 4: Groundwater exploitation in Punjab, 1984 to 2004

Water blocks/year	1984	1989	1991	1997	2004
Over-developed	53 (44.92)	62 (52.54)	62 (52.54)	73 (52.90)	104 (75.91)
Developed	7 (5.93)	7 (5.93)	8 (6.78)	11 (7.97)	9 (6.57)
Grey	22 (18.64)	20 (16.95)	15 (12.71)	16 (11.59)	8 (5.84)
White	36 (30.51)	29 (24.58)	33 (27.97)	38 (27.54)	16 (11.68)
Total number of water blocks	118 (100.00)	118 (100.00)	118 (100.00)	138 (100.00)	137 (100.00)

Note: i) Figures in parentheses indicate percentages to the total number of water blocks

ii) Overdeveloped blocks are those where withdrawal of groundwater was more than 100 per cent of the recharge of water. In dark blocks, the withdrawal of groundwater was between 85 per cent and 100 per cent of the recharge of water. In grey block, the withdrawal of Groundwater was between 60 per cent and 85 per cent of recharge of water. In whole blocks, the withdrawal of groundwater was less than 60 per cent of the recharge of water.

Source: Water Resources Directorate, Punjab, Chandigarh

Ropar district and 20 per cent for Hoshiarpur district. As far as the state as a whole was concerned, about 76 per cent of the water blocks were over developed. The share of dark blocks was about seven per cent, grey blocks about six per cent and white blocks about 12 per cent.

Keeping in view the problem of the declining water table and other related issues, the Punjab Government constituted the committee under the chairmanship of Dr S S Johl, an eminent agricultural economist, to suggest various measures for the diversification of agriculture in Punjab. The committee suggested that one million hectares of area, each under paddy and wheat, may be replaced with other crops particularly oilseeds and pulses. According to the existing water resources of the state, we can sustain paddy in about 16 lakh hectares only. But due to various reasons, the recommendations of this committee have not been implemented as such by the Government of India. The severe drought in the year 2002-03 resulted in fall of foodgrain production by about 38 million tones in a year. The buffer stocks also declined considerably. Rather, India has been forced to import 3.5 million tones of wheat in the year 2006. Since food security of the country is in the hands of the Punjab farmers, therefore, shifting of 10 lakh hectares of paddy area to other crops in the near future will be a very difficult task. The policy framework and market infrastructure are in favour of wheat and paddy crops.

Table 5: District-wise categorization of water blocks in Punjab 2004

District	Over-developed (OD)	Dark (D)	Grey (G)	White (W)	Total number of water blocks
Amritsar	16 (100.00)	-	-	-	16 (100.00)
Bathinda	4 (57.14)	-	1 (14.29)	2 (28.57)	7 (100.00)
Faridkot	2 (100.00)	-	-	-	2 (100.00)
Fatehgarh Sahib	5 (100.00)	-	-	-	5 (100.00)
Ferozepur	7 (70.00)	1 (10.00)	-	2 (20.00)	10 (100.00)
Gurdaspur	8 (57.14)	2 (14.29)	2 (14.29)	2 (14.28)	14 (100.00)
Hoshiarpur	2 (20.00)	2 (20.00)	3 (30.00)	3 (30.00)	10 (100.00)
Jalandhar	10 (100.00)	-	-	-	10 (100.00)
Kapurthala	5 (100.00)	-	-	-	5 (100.00)
Ludhiana	10 (90.91)	1 (9.09)	-	-	11 (100.00)
Mansa	5 (100.00)	-	-	-	5 (100.00)
Moga	5 (100.00)	-	-	-	5 (100.00)
Muktsar	-	-	1 (25.00)	3 (75.00)	4 (100.00)
Nawan Shahr	3 (60.00)	-	-	2 (40.00)	5 (100.00)
Patiala	8 (88.89)	-	1 (11.11)	-	9 (100.00)
Ropar	2 (28.57)	3 (42.86)	-	2 (28.57)	7 (100.00)
Sangrur	12 (100.00)	-	-	-	12 (100.00)
Punjab	104 (75.91)	9 (6.57)	8 (5.84)	16 (11.68)	137 (100.00)

Source: Water Resources Directorate, Punjab, Chandigarh

Note: Figures in parentheses indicate percentages to the total number of water blocks

Compound growth rates of area, production and yield

The compound growth rates of area, production and yield for important crops of the state are shown in Table 6. A perusal of the figures shows that rice production recorded the higher growth, i.e. 18.41 per cent per annum from the years 1966-67 to 1980-81. The contribution of area and yield was 11 per cent and 6.67 per cent respectively. Among the cereals, wheat was the next crop to record a high production growth rate (6.48 per cent per annum) during this period. The contribution of area in this was 3.34 per cent and yield contributed 3.05 per cent.

Potato and American cotton also recorded significant production growth rates of 13.30 per cent and 8.09 per cent respectively in this period. In case of potatoes, the contribution of area was 9.38 per cent and that of yield 3.66 per cent. In case of cotton (A), the increase in production mainly occurred as a result of increase in area (7.37 per cent) and contribution of yield was (-) 0.11 per cent. Sugarcane witnessed a negligible growth rate of 0.23 per cent. Other crops like maize, barley, bajra, pulses, oilseeds and cotton (D) had negative growth rates for production during this period. This happened primarily on account of decrease in area. Area released from maize crop in kharif season was largely replaced by the paddy crop and that from pulses and oilseeds to wheat in the rabi season. The area under cotton (D) has mainly been replaced by cotton (A).

The compound growth rates of area, production and yield of important crops in the state for the period 1981-82 to 1990-91 revealed that rice crop again recorded the highest production growth rate. It was 5.61 per cent per annum. The contribution of area was 4.85 per cent and that of yield 0.72 per cent. Among the cereals, wheat was the next crop to record 3.70 per cent per annum production growth rate. The contribution of area was 0.97 per cent and that of yield 2.70 per cent. The cotton (A) recorded 11.16 per cent production growth rate. In this, the contribution of area and yield was 2.79 per cent and 8.15 per cent respectively. The sugarcane also did not show a high growth rate in this period. The crops like maize, barley, bajra, pulses, oilseeds, potato and cotton (A) showed the negative production growth rates. It happened mainly due to decrease in area under these crops.

During the period 1991-92 to 2002-03, the production growth rates of rice and wheat were low as compared to the earlier periods, i.e. 1966-67 to 1980-81 and 1981-82 to 1990-91. Among the cereals crops, the production growth rate of rice was 2.67 per cent per annum

Table 6: Compound growth rate of area, production and yield of important crops in Punjab

Sr. No.	Crop	Area	Production	Yield
		1966-67 to 1980-81		
1	Rice	11.00***	18.41***	6.67***
2	Wheat	3.34***	6.48***	3.05***
3	Maize	–1.33*	–0.90NS	0.42NS
4	Barley	–4.44*	–0.30NS	4.21***
5	Bajra	–7.92***	–7.27***	0.71NS
6	Pulses	–3.36***	–4.05***	–0.72NS
7	Oilseeds	–2.91***	–2.91***	–0.0009NS
8	Sugarcane	–4.15***	0.23NS	4.55***
9	Potato	9.38***	13.30***	3.66***
10	Cotton (A)	7.37***	8.09***	–0.11NS
11	Cotton (D)	–1.77*	–2.91**	–1.65***
		1981-82 to 1990-91		
1	Rice	4.85***	5.61***	0.72NS
2	Wheat	0.97***	3.70***	2.70***
3	Maize	–5.72***	–7.08***	–1.40NS
4	Barley	–8.79***	–3.32NS	6.08***
5	Bajra	–18.46***	–19.66***	–1.63NS
6	Pulses	–7.15***	–4.39*	2.97*
7	Oilseeds	–6.01***	–4.16NS	2.21*
8	Sugarcane	0.95NS	0.77NS	–0.80NS
9	Potato	–2.77NS	–2.01NS	–0.08NS
10	Cotton (A)	2.79NS	11.16***	8.15**
11	Cotton (D)	–9.07***	–3.52NS	6.09*
		1991-92 to 2002-03		
1	Rice	2.23***	2.67***	0.0042NS
2	Wheat	0.41***	2.02***	1.61***
3	Maize	–1.81***	0.90NS	2.54**
4	Barley	–5.44***	–3.60***	1.94***
5	Bajra	–4.98**	–3.19NS	–2.57**
6	Pulses	–7.39***	–9.22***	–1.98**
7	Oilseeds	–7.89***	–10.55***	–2.88***
8	Sugarcane	3.36*	3.29NS	–0.08NS
9	Potato	11.04*	11.74***	0.49NS
10	Cotton (A)	–4.48***	9.14***	–4.88*
11	Cotton (D)	3.58NS	2.87NS	–0.73NS
		1966-67 to 2002-03		
1	Rice	6.58***	9.17***	2.43***
2	Wheat	1.63***	4.24***	2.57***
3	Maize	–4.22***	–2.83***	1.43***
4	Barley	–3.48***	0.60NS	4.33***
5	Bajra	–11.40***	–11.85***	–0.25NS
6	Pulses	–6.76***	–6.97***	–0.23NS
7	Oilseeds	–3.34***	–2.17**	1.21NS
8	Sugarcane	–0.15NS	1.34NS	1.49NS
9	Potato	3.27***	4.41***	1.07NS
10	Cotton (A)	2.46**	2.74**	0.19NS
11	Cotton (D)	–3.33***	–3.15***	0.06NS

Note: NS, ***, **, * indicate non-significant and significant at 1 per cent, 5 per cent and 10 per cent respectively.

from the years 1991-92 to 2002-03. The increase in production was mainly due to increase in area, i.e. 2.23 per cent per annum. The contribution of yield was non-significant, i.e. 0.0042 per cent per annum. The major reason for increase in rice area during this period was replacement of cotton (A) by the farmers with rice. Due to attack of American bollworm on the cotton (A) crop on a large scale during this period, the farmers had no option but to shift to paddy crop in the kharif season. In the cotton belt, the ground water is brackish and unfit for water intensive crop like paddy. But economic hardships faced by the farmers due to failure of cotton (A) crop forced them to shift to rice cultivation.

Wheat crop recorded a production growth rate of 2.02 per cent per annum during the period 1991-92 to 2002-03. The contribution of area and yield was 0.41 per cent and 1.61 per cent respectively. Potato crop witnessed significant production growth rate, i.e. 11.74 per cent per annum during this period. The contribution of area and yield was 11.04 per cent and 0.49 per cent respectively. Sugarcane production also witnessed the growth rate of 3.29 per cent per annum. It happened mainly due to increase in area, i.e. 3.36 per cent per annum. The contribution of yield was non-significant (-) 0.08 per cent. The cotton (D) showed 2.87 per cent production growth rate whereas cotton (A) production declined by (-) 9.14 per cent per annum. The other crops like barley, bajra, pulses and oilseeds showed negative production growth rates. Maize crop witnessed non-significant 0.90 per cent production growth rate.

The overall growth rate of area, production and yield of important crops for the period 1966-67 to 2002-03 indicated that rice crop was at number one having the highest production growth rate, i.e. 9.17 per cent per annum. The contribution of area and yield was 6.58 per cent and 2.43 per cent respectively for the increase in rice production. Among the cereal crops, wheat was next important crop having 4.24 per cent growth rate in production. The contribution of area was 1.63 per cent and yield 2.57 per cent. The growth rate of production of cotton (A) was 2.74. The contribution of area was 2.46 per cent and that of yield was 0.19 per cent. Potato was another important crop which showed the growth rate of production, i.e. 4.41 per cent per annum. The contribution of area and yield was 3.27 per cent and 1.07 per cent respectively. Sugarcane recorded the production growth rate of 1.34 per cent per annum. This increase was mainly due to increase in productivity. Other crops like maize, bajra, pulses, oilseeds and cotton (D) recorded negative growth rates in production.

The overall comparison of growth rates of different periods show that Punjab agriculture is facing the problem of stagnation in production particularly in the last one decade. The slow down in the growth rates of different crops had a negative impact on the income and employment of the farmers as well as agricultural labourers. The area under different crops has almost reached to the maximum possible level. Any increase in area of particular crop will result in decline of another crop. In this way, the overall picture of Punjab agriculture may not change significantly.

Trends in production and productivity

The rice and wheat crops have shown a remarkable increase in production in the state during the last 37 years. But during the last few years, the production of wheat has declined from 159 lakh tones in 1999-2000 to about 142 lakh tones in 2002-03. Similarly, rice production has declined from about 92 lakh tones in 2000-01 to about 89 lakh tones in 2002-03. It may be mentioned here that weather also played an important role in production of various crops. Sometimes, it is favourable to the crops. On the other hand, it has also been unfavourable for many years. The floods in Punjab during the month of September, 1988, damaged the rice crop on a large scale and consequently, the rice production declined to about 49 lakh tones during 1988-89 compared to about 54 lakh tones in 1987-88 and about 59 lakh tones in 1986-87. The severe drought condition in 1987-88 also adversely affected the rice production of the state. As already discussed, the production of cotton (A) had declined over the last ten years due to attack of American bollworm. The production of other crops, except sugarcane and potato, has declined over time.

Productivity

The yield per unit of area is a good indication of the efficiency in production. The yield figures for important crops show that in case of wheat, the productivity after showing an increase during the initial years (during the period 1966-67 through 1971-72), showed no improvement during the period, i.e. 1972-73 to 1976-77 and stagnated around 24 quintals per hectare. In the later years, however, there was an improvement in productivity, although it was marked by inter-year fluctuation. In recent years, the maximum yield of wheat was 4696 kgs per hectare in 1999-2000. After that peak yield, it had started declining.

In case of rice, the productivity increased from 1185 kgs per hectare in 1966-67 to 3507 kgs per hectare in 1993-94. This meant about three times increase in pro-

Table 7: District-wise value productivity in relation to important variables in Punjab, average of 2001-02 and 2002-03

District	Value productivity (Rs per cultivated hect.)	Share in value output (per cent)	Share in net area sown (per cent)	Fertilizer use (kgs per hect.)	Cropping intensity (%age)	Area irrigated (%age)			No.of tractors per 000 hectares (net area sown) as on 30.6.02
						Overall	Tubewell	Canal	
Ludhiana	55222.99	8.60	7.20	222	198	100.00	97.53	2.47	96
Fatehgarh Sahib	53824.98	2.84	2.43	216*	186	100.00	98.26	1.74	103
Sangrur	53721.36	12.34	10.54	154	195	100.00	68.60	31.40	81
Kapurthala	52685.46	3.66	3.10	219	195	100.00	94.39	5.61	72
Patiala	50868.11	8.09	7.09	213	195	96.63	96.82	3.18	84
Moga	50511.49	5.19	4.70	180	196	99.55	76.57	23.43	92
Faridkot	46071.22	3.15	3.13	198	185	97.93	83.22	16.78	96
Jalandhar	45927.05	5.60	5.59	225	174	99.89	97.05	2.95	66
Muktsar	44263.73	5.18	5.37	164	193	95.94	98.10	1.90	72
Bathida	43679.74	6.68	7.02	152	186	98.47	21.88	78.12	57
Ferozepur	43366.93	10.57	11.19	154	186	99.74	64.77	35.23	41
Mansa	42001.06	4.24	4.63	150	187	97.76	20.59	79.41	45
Amritsar	41577.32	9.61	10.61	177	186	99.08	52.21	47.79	45
Gurdaspur	41363.40	6.22	6.90	164	168	77.29	89.09	10.91	54
Nawan Shaher	40630.47	2.11	2.38	165	174	84.46	96.48	3.52	47
Ropar	34427.00	2.18	2.90	163	170	80.04	90.66	9.34	73
Hoshiarpur	32833.89	3.68	5.13	124	162	73.99	86.33	13.67	41
State	45881.62	100.00	100.00	181	186	95.29	73.60	26.40	66

*Related to the year 2002-03.

ductivity during the period. After that, the yield witnessed a decline up to the year 1999-2000, but again showed an increase in 2000-01. It was 3506 kgs per hectare this year. It went to the level of 3545 kgs per hectare in 2001-02 but marginally declined to 3510 kgs per hectare in 2002-03. There were inter-year fluctuations in yield. This happened due to floods, drought and crop disease. There is need for technological breakthrough in case of rice particularly hybrids.

The productivity of cotton (A) increased from 335 kgs per hectare in 1966-67 to 636 kgs in 1992-93. During this period also, there were inter-year fluctuations in productivity due to various factors. After 1992-93, the yield of cotton (A) started declining due to attack of the American bollworm and it reached to the lowest level of 179 kgs per hectare in 1998-99. In the subsequent years, it picked up. The yield of cotton (A) was 434 kgs per hectare in 2002-03.

The productivity analysis of other crops reveal that yield of maize, sugarcane, potato, oilseeds and barley crops has increased over time, although there were inter-year fluctuations due to various reasons. The productivity of pulses and cotton (D) did not show any remarkable improvement. To increase the production of various crops, there is need for technological breakthrough in productivity.

A case of stagnation

The productivity analysis reveals that breakthrough in productivity has been achieved mainly in few crops like rice, wheat, sugarcane, potato, maize and barley. Except for wheat and rice, the area under other crops is not quite large. There are marketing constraints for other crops because public procurement is effective only in case of wheat and paddy. In case of pulses, desi cotton and bajra, the productivity has almost stagnated. Overall also, Punjab agriculture is facing the problem of stagnation in production and productivity.

District-wise value productivity

It is interesting to point out that even in a relatively small state like Punjab, there are significant inter-district differentials in value productivity (Table 7). Ludhiana district came at the top with value productivity of about Rs 55,223 per hectare as compared to only about Rs 32,834 per hectare for Hoshiarpur district during the years 2001-02 and 2002-03. The other two districts next to Ludhiana were Fatehgarh Sahib and Sangrur, with value productivity at about Rs 53,825 and Rs 53,721 per hectare respectively. Ropar district had quite low productivity, i.e. Rs 34,427 per hectare. The other districts fell in between these extremes. These figures show that top three districts of Ludhiana, Fatehgarh Sahib and Sangrur had value productivity which was about 61 per cent higher as compared to the bottom two districts, i.e. Hoshiarpur and Ropar. The value productivity of the state as a whole was about Rs 45,882 per hectare. Eight districts had high value productivity as compared to the state average. These eight districts were Ludhiana, Fatehgarh Sahib, Sangrur, Kapurthala, Patiala, Moga, Faridkot and Jalandhar. On the other hand, nine districts had lower value productivity than the state average. These nine districts were Muktsar, Bathinda, Ferozepur, Mansa, Amritsar, Gurdaspur, Nawan Shahr, Ropar and Hoshiarpur.

Factors associated with value productivity

It is a well-known fact that irrigation is the key variable which explains the variation in value productivity because it determines the use of other associated inputs such as fertilizer, index of mechanization as well as the cropping intensity. It can be seen from the figures given in Table 8 that, in general, districts with higher per cent area under irrigation as well as having a higher percentage area irrigated through tubewells, have higher value productivity and vice versa.

Future possibilities

It is often said that Punjab may not be able to add much to its agricultural production since it is already near saturation point so far as exploitation of new areas is concerned. Besides, water is going to become the most limiting resource in further intensification of agriculture. We are of the view that unless the states make rational use of its irrigation resource, it would be difficult to maintain even the present type of cropping pattern in the long run. Already the state is facing the problem of felling water level our vast areas in the central Punjab. This is coupled with water logging problem in some parts of south western districts where underground water is brackish. This does not, however, mean that there is no scope to increase agricultural production. Even with the known level of technology, it is possible to enhance agricultural production by bridging the adoption gaps.

There are sizeable productivity differentials among districts which are otherwise more or less homogenous with respect to availability of irrigation facilities and soil type. It should be possible to increase the productivity levels in these districts by giving due attention to the limiting factors in these districts.

As far as diversification of crops is concerned, we are of the view that alternative crops should provide net returns almost equal to wheat and paddy crops. Only then, the farmers will shift to those crops. In this regard, production technology and marketing will have to play a crucial role. At present, the farmers face problems related to these issues.

Conclusion

Punjab agriculture, which was growing fast earlier, has now reached a sort of plateau in terms of productivity and production. In the wake of a declining land man ratio, it is not able to generate gainful employment and sufficient income for the growing population. Farm profitability has witnessed a decline in the recent years due to cost price squeeze. There is almost stagnation in farm income. Farming alone is not able to generate sufficient income for small and marginal farmers. Due to economic distress, 2,116 farmers had committed suicide over the last 15 years in the State.

At present, the farm indebtedness is to the extent of about Rs 26,000 crore which works out to be about Rs 2.61 lakh per farming household. The Punjab farmers are in deep economic crisis. There is acute unemployment and under-employment problem in rural areas. All of them can not be provided jobs in the public and private sectors. The National Rural Employment Guarantee Scheme is a right step in the right direction. Under this scheme, 100 days employment is guaranteed to one person in each rural household. In the first phase, Hoshiarpur district has been included in the scheme. We strong recommend that this scheme may be extended to all the districts of the State over the next 2 to 3 years. This scheme will provide employment to the rural masses and ultimately their income level will also rise.

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Thrift means that you should always have the best you can possibly afford, when the thing has an reference to your physical and mental health, to your growth in efficiency and power.

– Orison Swett Marden

Book Review

Apparel and Textile Exports: Strategies for WTO Era ***by Dr. Pradeep Joshi,*** published by CBS Publishers and Distributors, New Delhi, 2006, pages 217+ Foreward, Preface, Abbreviations and Contents, Price Rs. 395/- (Soft cover).

The book under review deals with the up to date research on the topic of global competition in post MFA era for the old and important apparel and textile industry of India. Opening up of the world market has created both challenges and opportunities. The book points out the problems of Apparel and Textile industry along with strategic options for being competitive in the long run. Indian apparel and textile sector is very critical to the Indian economy, being the highest net foreign exchange earner for the country. The phased removal of textile and apparel quotas since 1995 has catapulted Indian export firms in this ector into a new competitive environment.

Though India has emerged as one of the main textile and clothing exporting countries, low and stagnant market share in the world textile and clothing trade, comparatively lower unit value realization, lack of presence in high value segment and aggressive performance of other Asian countries are concerns of Indian apparel and textile industry.

The book under review is the offshoot of the doctoral research work that the author has undertaken at Indian Institute of Technology Delhi. The approach in this book entails an effort to understand the Indian apparel and textile industry and environment scan, to identify the opportunities to be captured. Primary research with the structured survey of various stakeholders of textile industry has been conducted to identify steps and initiatives need to be taken by the industry and government to become competitive in WTO era.

The book under review has been organized in seven chapters. First chapter presents an introduction to the evolution of apparel and textile industry and the changes in the global apparel and textile trade environment. Trade restrictions on apparel and textile industry have been discussed with focus on the implications of phasing out of the quotas along with brief trends in trade in WTO era. Trends in WTO era (post 1st Jan 2005) have indicated sharp gains for China forcing US, EU to take steps to restrict imports from China. Besides it, India, Bangladesh, Srilanka and Pakistan have also benefited from phasing out of quotas.

Second chapter analyses the Indian apparel and textile industry, covering its composition and a SWOT analysis. This chapter reveals that textile exports have emerged as the largest net foreign exchange earner for the country, contributing around 21% of India's total export earnings. The number of spinning mills has increased in the last decade while the number weaving mills are stagnant. Weaving sector is characterized with large presence of unorganized powerloom sector.

The third chapter presents a detailed account of competitiveness of Indian industry in the global market. The performance of various sectors of Indian apparel and textile industry is evaluated along with neighouring Asian countries so as to understand competitive position of India in world trade. The chapter reveals that India is catering to rather lower end of the market in key destination markets of apparel i.e. US and EU.

The fourth chapter analyses the competitiveness of Indian Apparel Industry based on the field survey of apparel exporters, fabric manufacturers and buying houses from the major textile producing clusters. The survey reveals that the productivity of Indian firm is rather poor in comparison to world. Both of these facts give the image of low end operator to India in world apparel market and cause lesser sourcing of high value item from India.

Fifth chapter shows the perception of the buying houses collected from the field survey that the quality of fabric from imported sources are superior to domestic fabric. The composition of the fabric indicates concentration on woven category where as the demand is in-

creasing for knitted categories in last few years. The factor analysis also indicate the market and R&D function along with production and quality function are responsible for lesser focus on manufacturing of high quality fabrics.

The sixth chapter deals with opportunities in post MFA period along with expectations from trade and government to be competitive in world trade. It has been identified that world trade in T-shirts, Gents shirts, Ladies blouses, Ladies dresses and Trousers are the apparel categories expected to provide opportunities in post MFA scenario. It was also noted that the Indian fabric manufacturers need to improve quality of product by improving raw material quality and investment in latest technology while having cost control to remain cost competitive and face competition from imported fabric by offering latest and contemporary design as per customers' requirement.

Chapter seven covers the suggested strategies for Indian apparel and textile industry for WTO era. The points out that as world textile and apparel trade is shifting to apparel, India can remain competitive in quota free world with competitive advantages in each element of value chain of manufacturing by incorporating latest technology in weaving and processing, research and development. The efforts are required to change the perception of buyers towards Indian fabric.

As a whole the book under review provides valuable information regarding the competitiveness of the Indian textile and apparel industry based on detailed analysis of published data sources as well as from the field survey of apparel exporters, manufacturers and buying houses. Moreover, this study identifies gaps on current strategy of apparel and textile industry and provides fresh insights into the pattern of emerging trade in the global textile and apparel market especially during the post MFA era.

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The natural flights of the human mind are not from pleasure to pleasure but from hope to hope.

– Samuel Johnson

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It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change.

– Charles Darwin

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