Monthly Multidisciplinary
Research Journal

Indian Streams Research Journal

Technology Management

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Abstract: Technology has become a competitive advantage for any organization. In order to compete with the competitors, Technology has become the only weapon to any organization. But, unfortunately the nature of the Technology is dynamic and unpredictable. Managing technology, especially disruptive technologies has become a demanding job for any organization. This article gives an overview on fundamental concepts of managing technology effectively; it deals with process of technological innovation and technological planning in an organization. Tool for technology forecasting is technology life cycle and different forecasting techniques are explained. Sources for the technology acquisition and different methods for acquiring the technology are enlightened. Concept of Diffusion, Integrated diffusion strategy and different diffusion theories are given explanation. Thought of absorption of technology put in plain words and Definition of Technology Transfer, Classification, Models and different modes of technology transfer are discussed.

Keyword: Technology, Management, Technology Forecasting, Technology Diffusion, Technology Transfer, Technology Acquisition, Innovation.

INTRODUCTION:

The organization can be nonprofit or for-profit both types are considered production organizations, with production being any activity that results in the conversion of resources into goods or services. Technology's contribution is not only in how goods and services can be produced but also in what can be or even has the potential to be produced. In the post, the value of a company was assessed largely on the basis of its capital and physical assets such as land, buildings, equipment, and inventory. Today, the real value of a company is much more than the value of its physical assets or its simple accounting net worth. Technology adds value to the assets of a company.

Technology can be defined as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services. Science deals with understanding the laws of nature. This leads to the discovery of fundamental knowledge about the world, the universe, and all living things. It is when scientific knowledge enters the realm of technology. It is common to think of technology in terms of hardware, such as machines computers, or highly advanced electronic gadgets. However, technology embraces a lot more than just machines. There are several technological entities besides hardware, including software and human skills. Zeleny (1986) highlighted this point by proposing that any technology consists of three interdependent, codetermining and equally important components!

Hardware: The physical configuration and logical design of the equipment or machinery, which is tangible, that is to be used to carry out the required task.
Software: The knowledge which is intangible used for the functioning of hardware in order to carry out the required tasks.

Brain ware: Analyzing the functionality of the technology with causality.

Know-how: Knowledge of how to do things or tasks effectively which is a result of experience or by technology transfer.

CLASSIFICATION OF TECHNOLOGY:-
New technology:

A technology which is newly introduced which can have its influence on the products of an organization.

Emerging Technology:

A technology is that is not yet fully commercialized but will become so within about five years is an emerging technology. Some of the important features of the emerging technology are, it employs highly educated large people and high costs are to be incurred on research and development.

Low technology:

The term low technology refers to technologies that have permeated large segments of human society. Low technologies are utilized by a wide variety of industries having the following characteristics:
They employ people with relatively low levels of education or skill.
They use manual or semiautomatic operations.
They have low levels of research expenditure.
The technology base is stable with little change.
The products produced are mostly of the type that satisfies basic human needs such as food, shelter, clothing and basic human services.

Swathi Krishana. Aluri And Kancharla. Anil Babu, "Technology Management "
Indian Streams Research Journal Vol-3, Issue-7 (Aug 2013): Online & Print

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Medium technology:

As used in this text, the term medium technology comprises a wide set of technologies that fall between high and low technologies.

Appropriate Technology:

The term appropriate technology is used to indicate a good match between the technology utilized and resources required for its optimal use.

Tacit technology:

Tacit technology is non-articulated knowledge. There is no uniformity in the way it is presented or expressed to a large group of people. It is usually based on experience and therefore remains within the minds of developers. The technology developers are the ones who have the know-how in question.

Codified technology:

Codified technology, on the other hand, allows people to know how technology works but not necessarily why it works in a certain way. The brain ware may be part of the tacit knowledge kept in minds of developers and shaped by their experiences during the development process.

Management:-

Management is an art and to some extent a technology. Management is also a technology, as it is the means by which the desired goals of an enterprise are achieved. Management functions in an organization includes planning, organizing, staffing, motivating an controlling activities of the organization. Management, as a, field, has a knowledge base and guiding principles. The term management technology implies technology used to manage organizations or certain functions.

Management of Technology :-

Management of Technology is an interdisciplinary field that integrates science, engineering and management knowledge and practice.

A U.S National Research council report (1987) on management of technology defined it as "an interdisciplinary field concerned with the planning, development and implementation of technological capabilities to shape and accomplish the operational and strategic objectives of an organization".

The Association of Technology, Management and Applied Engineering defines "Technology management as the field of study that impacts skills and knowledge, designed to improve the entire process of technological change and from systems planning and design, to introduction, to evaluation of effectiveness".

Management of technology links engineering, science and management disciplines to plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of organization.

In order to maintain technology and cop date the technology with the current changes. There are steps of process for every organization has to understand the fundamental concepts of the technology management.

1.Process of Technological innovation
2.Technology planning
3.Technology force casting.
4.Technology Acquisition
5.Technology Diffusion
6.Technology Absorption
7.Technology Transfer.

Process of Technological Innovation :-

The process of technological innovation is a complex set of activities that transforms ideas and scientific knowledge into physical reality and real world application. There are eight stages in the process of technological innovation.

1.Basic research: This is research for the sake of increasing our general understanding of laws of nature. It is a process of generating knowledge over a long period of time. It may or may not result in specific application.

2.Applied research: This is research directed toward solving one or more of society's problems. Basic and applied research advance sciences by systematically building knowledge on previous knowledge. Successful applied research results in technology development and implementation.

3.Technology development: This is a human activity that converts knowledge and ideas into physical hardware, software, or service. It may involve demonstrating the feasibility of an idea, verifying a design concept, or building and testing a prototype.

4.Technology implementation:
5.Production
6.Marketing
7.Proliferation
8.Technology enhancement.

Technology Planning :

Technology planning is a central component of

corporate business planning. It is needed both at the corporate level and at the strategic business unit level. Strategizing should be creative and revolutionary, while planning is systematic and follows established methodologies. The strategic planning time horizon may vary according to the organization's objectives. Several models have been proposed a technology planning frame work based on the work of madox, Anthon's and wheatley (1987).

Technology planning frame work :-
Forecast the technology
Internally owned and external technologies
Analyze and forecast the environment
Focus on analysis of opportunities and threats
Analyze and forecast the market/user
Real quality is the fulfillment of customer requirements and desires (Crosby 1979)

Analyze the organization
Focus on strengths and weaknesses

Develop the mission
· Specify objectives, targets and measurement of achievements

Design organizational actions
Create an action plan.
Put the plan in to operation
Sub-objectives, follow-up actions, control mechanisms
Appropriate technology

Tools for company – Technology Analysis :-
A variety of tools are available to analyze technology needs of an organization. Some of the important ones are described here.

1.Technology Audit :-
A technology audit is an analysis performed to identify the strengths and weaknesses of the technological assets of an organization. Its aim is to assess the firm's position in technology in relation to its. This applies to technologies of the entire value added functions in the firm, including product technology, production technology, service technology, and marketing technology. The technology audit is a continuous process of assessment.

Market – Technology (M-T) Matrix : -
Market – Technology matrix to analyze the technical and marketing competence necessary for strategic decision making in a product innovation. A company can be classified as having a low, medium or high levels of a certain criterion such s market competence. It is obvious that high cutting edge technology can assure success to companies having high or moderate market competence.

Market – Technology matrix :-

Market Competence → Technical Competence ⇩	High	Medium	Low
High cutting edge medium state of the art	Star ? Success ?	Success ? Doubt ?	Doubt ? Failure ?
Low obsolete	Doubt ?	Failure ?	Digester ?

Technology Road May :-
Motorola developed a corporate wide technology planning tool called the technology road map. The product road map is a systematic planning tool that is effective in managing a complex technological environment in each individual business within a firm. The product technology road map has eight sections:

1.Description of the business
2.Technology forecast
3.Technology road map matrix
4.Quality to be built into both products and processes.
5.Allocation of resources.
6.Patent portfolio.
7.Product description and status reports.
8.Minority report (a potential beneficial product, process or technology that has not been fully considered is brought to the attention of management).

Technology forecasting
According to Stanton Technological forecasting is" the process of predicting the future characteristics and timing of technology. When a possible, the prediction will be quantified, made through a specific logic and will estimate the timing and degree of change in technological parameters, attributes and capabilities".
Before discussing the technology forecasting let us discuss an important model very useful for forecasting is s-curve of technological progress.

The time invention period is characterized by a period of slow initial growth. This is the time when experimentation and initial bugs are worked out of the system. The technology improvement period is characterized by rapid and sustained growth.
The mature – technology period stats when the upper limit of the technology is approached and progress in performance slow down. This is when technology reaches its natural limits as dictated by factory such as physical limits.

This model of s-curve is also known as the technology life cycle helps to know about the life stage of the technology

Forecasting process:-

Trends or event ⟹ Inputs ⟹ Methodology ⟹ Outputs ⟹Purpose

1. Economic	1. Assumption	(forecasting	1. Phenomena, Business
2. Technological	2. Insights	techniques)	attribute, events technical
3. Social/political	3. Data		2. Measures,
			Pala metes
			3. Time probability
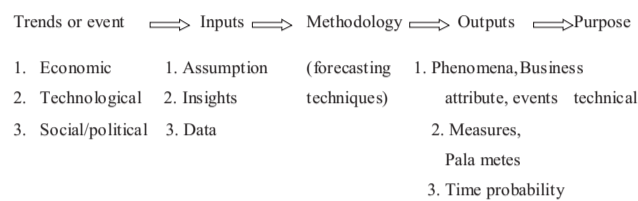
CLASSIFICATION OF FORECASTING TECHNIQUES:

Forecasting Techniques are mainly classified into two types

i)Numeric data-based Technological forecasting Techniques
ii)Judgment Based

Numeric Data based Technological Forecasting Techniques:

Numeric data based forecasting extrapolates humbly by generating statistical fits to historical data.

Trend Extrapolation :

To extrapolate is to in per the future feature from post. It can be distinguish between four approaches with the use of trend extrapolation.

1.Statistical Curve fitting: This method is applicable to forecasting functional capabilities. Statistical procedures fit the post data to one or more mathematical functions such the past data to one or more mathematical functions such as linear, logarithmic, Fourier or exponential.
2.Limit Analysis : Ultimately, all growth is limited and there is an absolute limit to progress, either recognized or un recognized sooner or later, projects must reflect the fact that improvements may get close to this limit but cannot exceed it.
3.Trend Correlation : At, times one technology is a precursor to another. This is frequently the case when advances made in the pre-cursor technology can be adopted by follower technology. When such relationships exist, knowledge of change in the precursor technology can be used to predict the course of the follower technology, as far in future as the lag time between the two.

Multi Trend Correlation :

Occasionally, a follower technology is dependent on several precursor technology rather than on a single precursor. In such cases, the follower is usually a composite or aggregate of several pre cursors. Fitted combinations of the precursors may act to produce change in the follower, but more often the combinations are not fixed and the precursor inputs vary in both combinations strength.

Judgment Based Technological Forecasting Techniques :

Judgmental forecasting may also be based an projections of the past, but information sources in such models rely on the subjective judgments of experts.

Monitoring : Monitoring is the process of scanning the environment for information about the subject of a forecast. It is not really a forecasting technique, but rather a method for gathering and organizing information. The sources of information are identified and then information is gatherer, filtered and structured for use in forecasting.

Delphi Method :

The bask known of the various judgment approaches to technological forecasting, the Delphi Method uses a panel of individuals who make anonymous, subjective judgments about the probable time when a specific technological capabilities will be available. The results of these estimates are aggregated by a process administrator and feed back to the group, which then uses the feedback to generate another round of judgments.

Scenarios :

Scenarios are sets of snapshots of some aspects of the future and / or future histories leading from the present to the future. The scenario set encompasses the plausible range of possibilities for some aspect of the future.

Technology Acquisition :

Technology planning encompasses the development of plans for the acquisition of technologies that will impact a firms competitiveness. Information about these technologies is derived from technology audits that detail all technologies and sub technologies used in the value chair.

SOURCES OF TECHNOLOGY ACQUISITION :
Internal Technology Acquisition :

Internal technology acquisition is the requite of technology development efforts that are initiated and controlled by the company itself. Internal acquisition required the existence of a technological capability in the company.

EXTERNAL TECHNOLOGY ACQUISITION :

External technology acquisition is the process of acquiring technology developed by other for use in the company. External technology acquisition generally has the advantage of reduced cost and time to implement, and lower risks.

METHODS OF ACQUIRING TECHNOLOGY :
Using internal R & D
Requires strong technical and financial support
Participating in a Joint Venture
Collaboration between two or more firms
Contracting our for R & D
Lower investment in R & D
Licensing of Technology
Development costs, product costs, time, expertise
Buying Technology from others
Outright purchase of technology
Less control on technology
Need strong relationship with the supplier
Service facilities are important

Technology Diffusion :

Diffusion is the process by which on innovation is communicated, over time, through certain channels to members of a social system.

Integrated Diffusion Strategy

Ideation :

In this stage ideas are generated. Involvement in identifying gaps between needs and products in problem definition and idea generation.

Incubation:

To find solution, one relaxes by relegating the problem to the background. One would be in a society individual world. No interactions.

Illumination :

The solution sparks.

Externalization :

Ideas are tested for acceptance. Management should help people prepure their ideas for presentation within and outside the organization.

Development :

The idea is selected for development diffusion at this stage involves linking the basic scientist's work to the applied scientist's work and the world outside laborators through the comprehensive diffusion perspective.

Pilot Testing :

Marketing begins. The marketing department develops a description of the attributes of the new technology, selects channels for its marketing. Message and begins development of a promotional programs. Potential and trial users are surveyed for feedback.

Full Scale Diffusion :

It include a search for a wide range of potential markets that have not been explored and new way to couple the innovation with other innovations for new applications.

THEORIES OF DIFFUSION :

Innovation Decision Process :

The Innovation Decision process theory states that diffusion is a process that occurs over time and can be seen as having five district stages. The five stages in the process are knowledge, pervasion, Decision, implementation and confirmation.

Individual Innovativeness:

The Individual innovativeness theory states individuals who are predisposed to being innovative will adopt an innovation earlier than those who are less predisposed.

Rate of Adoption :

The third widely used diffusion theory discussed by Rogers is the theory of rate of adoption theory states that innovations are diffused over time in a pattern that resembles an s-shaped curve. Rate of Adoption theorizes that an innovation goes through a period of slow, gradual growth.

Perceived Attributes :

The theory of perceived attributes states that potential adopters judge an innovation based on their perceptions in regard to five attributes of the innovation. These attributes are: Trial ability, observability, Relative Advantage, complexity and compatibility.

Technology Absorption :

Technology is said to be understood if it is fully understood, so that it is in a position to be further optimized and upgraded. Technology absorption involves 'know-how' exercises, basic investigations into the product and / or process and / or systems. This will require whole packaging of technology package. To avoid further dependence, technology absorption requires R & D projects in know why, optimization and improvement of product/process/systems and related equipments. Such efforts encompass design investigations, alternative raw materials/components, modifications etc.

Technology Transfer:

According to Jain and Trend is Technology transfer can be defined as a process by which science and technologies are transferred from one individual or group to another that incorporates this new knowledge into its ways of doing things."

Categories of Technology Transfer

International technology transfer: The technology transfer took place between different countries.

Regional technology transfer: Transfer of technology with the country.

Cross-industry or cross-sector technology transfer: Transfer of technology between different industries, for example a machines are used for production factories, same machines are used for experiments in educational sectors.

Inter-firm technology transfer: The technology transfer between two companies of same industry, like joint ventures or collaborations.

Intra-firm technology transfer: The transfer of technology with in the departments of a company is known as Intra firm technology transfer.

Routes of Technology Transfer

General channels

Education, training, publications, conferences, study missions, exchange visits.

Reverse engineering channels

Capability of breaking the code and developing the duplicate in some form.

Protect from legal violations

Usually gained during product development process

Powerful method for technology transfer

Planned channels: With the consent of the owner and in a planned manner.

Licensing: Outright purchase or initial lumsum plus a percentage of sale.

Franchise: A form of licensing. Continual support from source viz., material supply, marketing, training, etc. Food chains is a good example.

Joint venture: Share resources to develop a technology, product. Compliment the know-how. Share rewards too. International JVs.

Turnkey project: From an outside source. Designed, implemented and delivered ready to operate. Training and continued operational support is a part.

FDI: MNCs deciding to invest in overseas. Technology remains within the boundaries of the firm. It has to be win-win situation. Investor gains access to work force, natural resources, technology or markets. Host country receives technological know-how, employment, training and capital investment.

Technical consortium and joint R&D project: Sharing of resources for a large venture. Usually between two countries or two large conglomerates.Ex. Development of Concorde between France and England.

Mergers and Acquisitions: Permanent changes to the structure of the firms involved. Of the two or more firms involved, one corporation survives. Surviving company completely absorbs the other companies.

Pricing of Technology Transfer
Licensing fee
Payments for use of technology
Minimum payments
Guaranteed amounts that are paid annually.
Cross-licensing agreements
Contracted supply of output
Royalties (25% Rule; Going Rate method; Return on Investment; Profit Sharing)

MODEL OF TECHNOLOGY TRANSFER :
Bridging Agencies :

The birding agencies that try to make technology transfer happen include government initiations, financial institutions, industries, R & D organizations etc.

Mission oriented agency that supports development of technology for purposes of its mission and the arranges for the technology diffusion to other industries by knowledge transfer.

Generation and technology transfer as a companion of problem solving.

Technology Transfer Summer Models :
Synthesis of the entire process of technology transfer on a large scale.

Technology Transfer Modes :
Passive Model :

The passive mode, also called dissemination mode. The most familiar and widely used form of passive technology transfer is the published literature. There is no director communicator.

Active Mode :
The active mode of technology transfer carrier the process through to an actual demonstration. In this mode the technology transfer agent or consultant will be fully involved and acts as a bridge in technology transfer from technology and acts as a bridge in technology transfer from technology source to entrepreneur or implementing agency.

CONCLUSION:
We have pictured the fundamental concepts of technology management for an organization. The process of technological innovation helps an organization to identify the stage of an idea is at and helps to frame technology planning and to develop the technology strategy. Technology life cycle helps to know about the stage of the technology in its life cycle and makes the forecasting process easy with different forecasting techniques. The concept of technology transfer provides an easy flow of technology into an organization, Concept of diffusion strategy and theories are useful in diffusion of technologies in any organization. Not only acquiring the technology but also the absorption of technology is also an important characteristic. Tough the technology is impulsive; by using the basic concepts any organization can get an outline on technology management.

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