**SET – I**

**Q. No 1. Define Science and Technology. In what way does Science and Technology support our survival and growth**

**Definitions of Science and Technology**

**Role of Science and Technology in Survival and Growth**

**Definitions of Science and Technology =>**

Science is the foundation of all technological innovations. For instance, the technology of sharing information across different departments in an organization is based on the science of electromagnetic waves.

Science can be defined as the systematic study of nature. There are numerous definitions of the word ‘science’. According to Webster's New Collegiate Dictionary, science is the "knowledge attained through study or practice," or "knowledge covering general truths of the operation of general laws, esp. as obtained and tested through scientific method [and] concerned with the physical world."

The application of science is known as technology. Therefore, all technological innovations, starting from mobile phones to the Internet, are based on scientific knowledge.

Technology refers to the application of science. For example, organizations use various technologies such as computing and networking. These technological applications are the result of accumulated scientific knowledge. Therefore, we can say that while technologies are the “how” of doing something, science is the “why” of something.

There are obviously different ways of doing things. A computer code can be written in different programming languages, but ultimately the programme has to meet the required objective. Technology gives a competitive edge to do things faster and cost-effective ways to achieve our objectives.

**Role of Science and Technology in Survival and Growth =>**

Adoption of technology is no more just an option but a compulsion for the organization. In a competitive market, every organization competes to increase market share. To attract and retain more customers, organizations need to provide superior products and services, increase customer satisfaction, connect to customers, and build customer relationships. Technology plays crucial roles in all these aspects of an organization. Most production processes have been automated, so that productivity can be increased manifold and manual errors can be eradicated. Technology ensures better quality assurance, which in turn increases customer satisfaction.

Technology also enables organizations to have a better insight into the needs and preferences of customers. IT has revolutionized data collection, sharing of information, and analyzing information. Business analytics techniques enable organizations to find meaningful insight from the huge amount of data collected by organizations. Therefore, today competition among organizations is based on their technological capabilities.

After the liberalization of the Indian economy in the year 1990, competition in the Indian market has increased manifold. This is because many well-established players have entered the Indian market. In such a scenario, the survival of Indian organizations would depend upon how fast they can adopt newer technology and innovate to provide better products and services. For instance, when many multinational banks entered India in the late 1990s, most processes in Indian banks were manually done with pen and paper.

However, these foreign banks were using computing technology and wire transfer of funds. Gradually, Indian banks adopted these technologies. Today, hardly any bank can survive in the market without modern technological facilities such as computing, ATM, and electronic fund transfer. Therefore, technology is very crucial for the survival as well as the growth of organizations.

**Q. No 2. According to the economists, Boskin and Lau (1992), there are three main sources of economic progress in a country. Explain them.**

**Explanation of the three main sources of economic progress in a country by Boskin and Lau (1992)**

**Explanation of the three main sources of economic progress in a country by Boskin and Lau (1992) =>**

Employment generation and wealth creation in a country depend upon the level of economic development in the country. Economic development greatly depends upon the technological development of a country. For instance, countries with the highest Gross Domestic Product (GDP), such as the USA, Japan, China, and Germany, are also technologically the most developed countries. Technology development increases production and productivity, which in turn create employment and wealth. For instance, before the industrial revolution in the Western countries, production activities were conducted manually. However, machines replaced manual labour after the industrial revolution. This technological advancement brought revolutionary changes in the economies of these countries.

Various economists have emphasized the role of technology in economic development. For instance, German economist Joseph Schumpeter emphasized the role of technological innovation in economic growth. According to him, technological innovation helps in production efficiency, expansion of market, and creation of wealth.

According to the economists, Boskin and Lau (1992), there are three main sources of economic progress in a country. These are as follows:

* **Enhanced capital:**

Capital refers to the produced goods and services that help in the production of other goods and services. Therefore, it includes buildings, machinery, etc.

* **Technical progress:**

It refers to the technological innovations that increase efficiency and productivity. For example, previously in banks most record-keeping activities were conducted manually in paper. However, after computerisation, banking transactions have been greatly simplified.Technical innovation at the macro-level provides a competitive advantage to a country over others. This competitive advantage helps in creating wealth and employment. For example, because of technical capability, Japan has a competitive advantage in manufacturing over countries such as India.

* **Labour:**

It refers to the human efforts put into the production of goods and services. Skill is the most important determinant of the usefulness of labourers in creating employment and wealth. Labourers need to possess the required skills, such as technical skills and communication skills, to excel in their jobs.

These capitals are the result of technological progress. Technology helps in the expansion of economy and job creation, because new technology initiates a new cycle of production, which requires a skilled labour force. For example, communication technology spurred the growth of the production of various communication devices, for example, mobile phones, networking devices, tablet computers, etc. Boom in the software industry in India has created a demand for millions of skilled workers in the software industry. According to a National Association of Software and Services Companies (NASSCOM) (Nasscom.in (2012). Indian IT-BPO Industry |) report, the Indian software industry was expected to add 2,30000 jobs in the Financial Year 2012-13.

**Q. No 3. Explain different types of Innovation. Explain the process of innovation.**

**a) Types of innovation**

**b) Process of innovation**

In simple words, innovation means doing something new and original. In the context of technology, innovation refers to the new applications of scientific knowledge to achieve various objectives such as creating wealth, increasing productivity and efficiency, reducing cost, and improving the standard of life.

**Types of innovation =>**

Innovation can be classified into different categories. In terms of offerings, there are three types of innovations:

* Product innovation
* Services innovation
* System innovation

In product innovation, either additional value is created in the existing products or new products are introduced in the market to capitalize on technological knowledge. For example, in the 1990s, Xerox introduced new Xerox copiers by applying artificial intelligence capable of predicting a possible break-down of the machine. Therefore, the new and more innovative machine helped in saving time and resources of users (Brown, 1991).

Services innovation, involves improving the existing service by introducing new ideas or various technological agents such as sophisticated software in service delivery. For instance, earlier, air travelers had to book their tickets from the offices of the respective airlines. However, the Internet revolution has made it possible to book air tickets online from anywhere.

In system innovation, numerous components of a system are improved for the overall efficiency and effectiveness of a system. For example, different components in a communication system are networks, modems, computers, optical fiber, etc. Innovation in these components results in an overall improvement of the entire system.

* **On the basis of flexibility, there are two types of innovations:**
* **Open innovation:**

It is more flexible to environmental feedback. In other words, in open innovations, an organization does not have a specific final product in mind. The concept is subject to change at various stages of

research.

* **Closed innovation:**

In closed innovation, the end product is defined at the beginning. There is very less flexibility for environmental feedback in the research stage.

* **In terms of scope, there are two types of innovations:**
* **Incremental innovation:**

In incremental innovation, an existing product, service, or system is improved. For example, dual-SIM mobile phone is the result of incremental innovations in the single-SIM mobile phone.

* **Radical innovation:**

In radical innovation, an old technology is made obsolete by the introduction of a new technology. For example, a mobile phone is the result of radical innovation on land-line phones. This is also called “disruptive innovation”.

**Process of innovation =>**

Technology is the implementation of scientific knowledge. For instance, the Internet is one of the most revolutionary innovations of recent times. In the invention of Internet, Advanced Research Projects Agency (ARPA), a US government agency, funded university researchers to study the nature and functions of electronic signal propagation, logical computing, and information to develop a computer-to-computer communication technology. This knowledge was further used to develop the Internet. Therefore, broadly, an innovation process can be categorized into three stages, as follows:

* Acquiring scientific knowledge of the natural laws
* Applying scientific knowledge to develop technology
* Marketing the technology

There are mainly three steps in innovation process, which are depicted below:

* **Research:**

In this step, scientists study the laws of the nature. Knowledge of natural laws is gained through the process of scientific discovery. For instance, the first step in the invention of television was how to convert pictures into electronic signals and then send electronic signals through cables.

* **Invent:**

Technologists use the knowledge of science to develop products and services that can resolve various human problems. For example, knowledge of X-ray led to the invention of X-ray machines, which help in detecting various defects in human bodies.

* **Commercialize:**

In this step, a new technological product is introduced in the market place and sold to customers. For instance, the iPod was a revolutionary product, which was extremely successful in the market because of its sleek design and excellent functionalities.

**SET - II**

**Q. No 1. What are the issues in strategic decision making in Technology Management? What are the 6 I’s of Strategic decision making?**

**a) Issues in Strategic decision-making**

**b) I’s of Strategic decision making**

Strategic decision making in an organization is immeasurable and quite difficult to perform, because it cannot be analyzed and explained easily. There are various issues in strategic decision making that may arise in an organization.

**Issues in Strategic decision making =>**

Following are the issues in strategic decision making:

* **Rationality in decision making:**

It implies that a final decision should be made from separate alternatives in such a way that the objectives of the organization are achieved in the best possible manner. A rational decision should take into consideration all the aspects of the organization such as profitability issues, optimization issues, and a consensus of all the members of the organization. Therefore, in case a rational decision does not consider all the available information, the decision is not as effective. For example, if an organization fails to properly map its technological capabilities, it cannot develop an effective technology strategy.

* **Creativity in decision making:**

It implies that a strategic decision should be unique and different in nature. Creativity in the decision-making process leads to explore the alternatives and achieving the objectives in an exceptional manner. This is the reason top technology companies, such as Google and Apple,emphasize a lot on acquiring creative individuals and maintaining a creative environment.

* **Volatility in decision making:**

It implies that every problem may have different solutions, depending on different perceptions of different individuals. Thus, it can be inferred that the process of strategic decision making involves volatility.

* **Different criteria for making strategic decisions:**

It implies setting objectives for making decisions. The three major criteria in strategic decision making are as follows:

* Maximization concept: This implies maximizing the returns.
* Pragmatic concept: It means setting objectives realistically and optimally.
* Incremental concept: This implies moving towards achieving the objectives through small incremental steps.
* **Individual factors in decision making:**

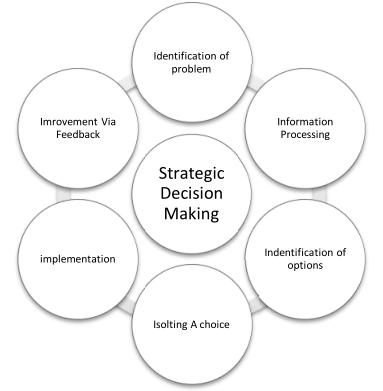
It implies that human factors, such as age, knowledge, creativity, and perceptions, play a significant role in strategic decision making. For instance, while taking social responsibility decisions, individual values, such as culture and beliefs, form the most important part.

* **Individual versus group decision making:**

This lead to differences in the strategic decision-making process. The strategic decisions taken by an individual, such as a chief executive officer or a manager, differs from the decisions taken by a group, such as a board of directors.

**I’s of Strategic decision making =>**

Strategic decision making is a continuous process. However, there are a number of models for generating strategy. 6 Is of strategic decision-making, as depicted in the following figure:



The 6Is are elaborated as follows:

1. **Identification of the problem:**

At this stage, an organization identifies the problems for which the strategic decision needs to be made. At this stage, a problem statement is prepared detailing the nature and the scope of the problem.

1. **Information processing:**

After identifying the problem(s), the organization needs to gather information regarding the problem and other internal and external factors. Next, the collected information is analyzed to gain more insight into the problem.

1. **Identification of options:**

At this stage, various available means of solving the problem are identified. An organization should focus on identifying as many options as possible.

1. **Isolating a choice:**

After identifying the options available to solve the problem at hand, the appropriate option needs to be selected. Various quantitative and qualitative methods can be applied to isolate the choice.

1. **Implementation:**

After the appropriate choice has been identified, the goal is to implement the choice. First, an implementation plan needs to be made. Thereafter, adequate resources need to be provided to implement the plan.

1. **Improvement via feedback:**

This step is conducted to ensure that the implementation was as per the plan. This is done with the help of measurable targets and feedbacks.

**Q. No 2. What is competitiveness and what are the indicators of competitiveness? Explain how technology helps in achieving Competitiveness.**

**a) Competitiveness and indicators of competitiveness**

**b) How technology helps in achieving competitiveness**

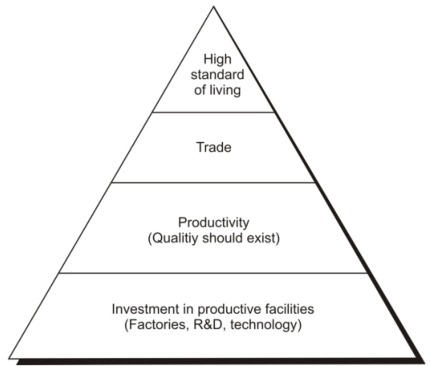
**Competitiveness and indicators of competitiveness =>**

Competitiveness refers to the process by which a person or entity outperforms another person or entity. The objective of competitiveness is to win. However, ability to win through competitiveness requires certain factors, such as commitment, capabilities, resources and planning.

An organization that possesses competitiveness is referred to as a competitive company. A competitive company must provide products and services that meet the need of the customers in a timely and cost-effective manner. To remain competitive, a company needs to continuously outperform its competitors in terms of costs of goods and services, quality, and other supporting services. However, given the high level of competition in the market, maintaining competitiveness becomes a very difficult task for companies.

At the national level, competitiveness refers to the relative strength of an economy (measured by per capita Gross Domestic Product or GDP) and the standard of living of people. National competitiveness is the resultant of the combined competitiveness of the individuals and organizations.

Below the hierarchy of national competitiveness:



Each of the elements of the pyramid is known as an indicator of competitiveness.

These indicators are briefly discussed as follows:

* **Investment:**

It is the driver of growth in any economy. Investment in infrastructure, technology, factory, equipment and skill building creates the foundation of economic growth.

* **Productivity:**

It refers to the produced output for a given amount of input. Productivity reflects the efficiency of production. Productivity depends on various factors, such as level of investment, quality of the plants and equipment, technological innovations etc. Productivity is a determinant as well as an indicator of competitiveness.

* **Trade:**

It consists of imports and exports. The level and growth rate of exports is a significant indicator of the national competitiveness. Some of the trade indices include balance of payment, growth in exports of manufactured products and services, and merchandises.

* **Standard of Living:**

This indicator is at the top of the national competitiveness pyramid. This is because improving the standard of living is the main objective of a free market economy. This is the reason the standard of living is the primary indicator of national competitiveness. The principal measure of standard of living is the per capita GDP.

**How technology helps in achieving competitiveness =>**

Competitiveness at the firm level refers to the ability of a firm in providing goods and services according to the requirements of the client in a timely and cost-efficient manner. In other words, a competitive firm attains the leadership position in a market.

Technology can be a great facilitator for a firm to achieve a highly competitive position. For example, technological companies, such as IBM, Google, Amazon, Apple Microsoft etc. leverage technology in such a way that they achieve the leadership position in their respective market. A firm can achieve competitiveness in a number of ways, such as having a clear vision and goal, employing a highly competitive and skilled workforce, deploying efficient technologies and equipment, developing aggressive marketing and branding strategies etc. However, we would keep our discussion limited to how technology helps firms in achieving competitiveness.

Following points elaborate on how technology helps in achieving competitiveness:

* **Innovative Products:**

Organizations develop innovative products with the help of technology. Innovative products help organizations in beating completion and maintain leadership position in the market. For example, iPod is a revolutionary technological product. The product was an instant success and helped Apple in achieving leadership position in the market.

* **Innovation in Production Processes:**

Technology helps a company in achieving competitiveness by revamping the production processes. For example, Japanese organizations pioneered applications of robotics and automation in the production processes. Naturally, Japanese companies such as Sony and Toyota were the first organizations to achieve competitiveness through automation and robotics.

* **Innovation in Supporting Functions:**

Technology helps in improving various supporting services, such as logistics, and marketing. For example, Walmart has developed one of the most efficient supply chains with the help of technological innovations, such as RFID (Radio Frequency Identification) to locate and manage the merchandises and networking technology to integrate the logistics system.

**Q. No 3. Explain the conceptual framework of Management of Technology.**

**Explaining the conceptual framework**

MOT refers to a set of management disciplines that enables organizations to manage their technological aspects to create competitive advantage. It is an interdisciplinary intersection of science, engineering, management knowledge, and practice. Technology management integrates various disciplines to enhance knowledge and intellectual capital, optimize utilization of resources, conserve the natural environment and other factors responsible for increasing the standard of living, and use technology for human advantage. MOT includes management of the aspects that are responsible for creation, acquisition, and exploitation of technology to enable human endeavors and satisfy customer needs.

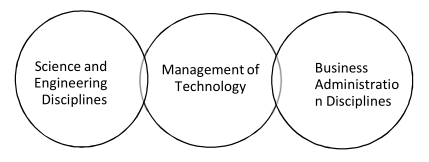
Research, development, and innovation are essential components in creation of better technology and enhancement of technological progress. Nevertheless, to use technology for the creation of wealth, it is important to commercialize technology. Technology needs to be connected to a customer for its benefits to be reaped. The customer could be an individual, a corporation, or a government entity.

While technology remains the most influential factor for wealth creation, many other factors contribute to the realization of wealth in a system such as capital, labour, social, political, and environmental conditions. Each of these factors of growth has its own disciplinary field of study and research. Knowledge acquired from the study of these factors, combined with technological development, contributes to MOT as an interdisciplinary intersection.

**Explaining the conceptual framework =>**

MOT creates an intersection of science, management, and engineering disciplines. The traditional fields in science and engineering contribute to scientific and technological discoveries. Similarly, traditional fields in business administration also contribute to the management of enterprises, economics, finance, marketing, and public policy. MOT links disciplines that focus on technology development, which leads to the creation of wealth.

Below the the conceptual framework of MOT:



MOT evaluates the following:

* How technology can be created
* How technology can be used to create business opportunities
* How technological strategies can be integrated with business strategies
* How technology can be used to gain competitive advantage
* How technology can be used to improve manufacturing and service processes
* How to manage organizational change to adapt to technological changes
* How technology can be used to ensure sustainability in the country
* How technology can be used to improve healthcare
* How can technology be used to enhance performance in sports
* How technology can be used to improve transportation
* How and when to adopt or abandon a technology

Management of Technology or MOT is essentially due to the fact that with change in technological paradigms, the management systems must also be adapted to cope with these changes. This leads to utilization of technology for wealth creation and customer satisfaction.