An Overview of Innovation and Dynamic Technological Changes in India

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Abstract

India has the distinction of being one of the pioneering developing countries that explicitly recognized science, technology, and innovation as a key factor in development. In fact, even before independence, there existed an active discourse on the adverse effect of colonialism and colonial science on nation building and the role of modern science and technology and self reliance therein for the development of the country. In this paper highlight overview of technological changes, meaning of technological change, indicate top technological changes in India.

*Keywords:*Technology, Development, AI, ML, IoT, 5G, VR,AR, 3D, GDP, R&D, India

Introduction

India, the world's second-largest populated country, has the potential to become an innovation hub, showcasing modern technologies to the rest of Asia and the world. Our thriving, educated young labour market and our prowess in technological developments are the two pillars that open up a world of opportunities for us in the fourth industrial revolution.

India has always been at the forefront of adopting new technologies and implementing them across industries. AI, IoT, blockchain, and other technologies are being studied to tackle some of the biggest challenges facing our industries. However, there are some roadblocks in adopting these technologies that are stifling our growth.

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India is today on the cusp of a technological change, especially in the manufacturing domain. In the next five years, a new global consumer class will develop, resulting in the creation of several new market opportunities. A robust pipeline of advancements in materials and processes from nanomaterials to 3-D printing to advanced robotics promises to create new demand and drive significant productivity gains across manufacturing industries and geographies as customers demand greater variety and more. *The next era of global growth and innovation hinges on* how technological transformations contribute to manufacturing.

Being the world's fastest-growing economy in the world, our country will be one of the key contributors to the global manufacturing industry. Today, amidst a global upheaval for the industry to do better, the manufacturing sector has altered substantially. The downstream aluminium sector, a key contributor to automotive, construction, power transmission, aerospace, defence, packaging, and a lot more areas is a great example of how new technology is modernising operations.

Overview

In the context of developing countries, the 1970s witnessed a discourse on the choice of technique, broadly within the neo-classical framework, suggesting that the pattern of technological choice is to be governed by relative factor prices. It is also implied that for developing countries, the key issue is one of choice and not of developing technology as the required technologies are available from the international technology shelf. The 1970s also witnessed the drafting of a the Sussex manifesto which underlined the need for bringing technology generation at the centre of the development discourse and called for redirecting science and technology to meet the needs of low income countries. Its main proposition was that developing countries that accounted for only about 10 per cent of global R&D should have their own scientific and technological capability both for increasing production and for improving the capacity to produce. Apart from calling for greater access to developing countries for technologies from advanced countries by establishing an international technology transfer bank, the manifesto also required the developing countries to raise their own R&D expenditure to 0.5 per cent of GDP. Although the manifesto was not accepted by its UN sponsors, it turned out to be a highly influential document among policymakers in developing countries like India and induced the developing countries to allocate greater resources for R&D.

Technological Change

The definition of **technological change** refers to the improvement of the already existing technologies and the invention of new ones to improve the existing products in the market while also creating new ones. This can be defined as the process of increasing the efficiency of a product or process resulting in an increase in output without increasing input. This is because, in technological change, a business does not have to start by assembling new raw materials to make a product but uses the same product and improves the initial technology to create a more superior product. Technology change also involves when somebody invents or improves a product, then it gets a bigger reward for the same amount of work. A bigger reward for the same amount of work is possible with a given level of input. The phases of technological change include **invention**, **innovation**, and **diffusion**. Technological change has a lot of advantages including enabling the creation of new products and processes, increasing efficiency, and lowering costs. One of the major disadvantages of technological change is that workers are less valuable to employers. This is because the new technology used is faster, efficient and the manufacturing techniques ensure less wastage than human labor.

Stages of Technological Change

Technological change has three important stages; Invention, innovation, and diffusion. They will be discussed as follows;

- *Invention:* Invention is the process of creating new technology or developing a product or a technological process by applying knowledge that was already in use, but in new ways. Inventions always begin as basic working models in which essential features are developed to gauge their chances of working. After the essential features are developed, an improvement that includes addition, subtraction, or modification is then carried out to the basic working models until every improvement that could be added to the essential features is exhausted. Since the invention is not an easy task and it requires a lot of trial and error, patents are usually handed over to the inventors which give them exclusive rights to sell the products or method invented.

- *Innovation:* This is the second stage of technological change and it refers to applying the inventions patented or discoveries to produce a useful product or a process. It is an idea, behavior, or product that is new to the adopters. There are two types of innovation; product

innovation and process innovation. Product innovation refers to the development of improved products while process innovation refers to using an improved method of production to create superior products. Despite the line between innovation and innovations being marginal, innovators cannot patent their innovations. Trade secrets however act as possible patents as employees have to sign a contract of nondisclosure.

- *Diffusion:* This is the last stage of technological change and it involves the spread of improved technology throughout the industry so that the pioneer company can remain competitive. It is also the process where new ideas or products are accepted by the market. Diffusion occurs in two processes: emulating and copying a competitor's company or processes. A company inspects the new goods produced by their competitors and works their way around producing the same goods or improving the already produced goods but without patenting the other inventors' ideas. Patents are narrow in scope and competing firms can reverse engineer the product to find a way around remodeling the product or improving it further.

Top New Technologies in India

Technology trends represent the latest shifts in the industry, and with the internet's influence, these changes occur rapidly. For professionals in the software industry, staying updated with these trends is crucial. As we progress into 2023, there are emerging technology trends that will shape our futuristic world.

- ❖ Artificial Intelligence (AI) and Machine Learning (ML)
- ❖ Internet of Things (IoT)
- ❖ 5G
- ❖ Virtual and augmented reality (VR/AR)
- ❖ Robotic Process Automation (RPA)
- ❖ Blockchain
- ❖ Quantum Computing
- ❖ Datafication
- ❖ Renewable Energy
- ❖ Autonomous Vehicles
- ❖ Digital Twins
- ❖ Edge Computing

❖ Cybersecurity

❖ 3D Printing

❖ Human Augmentation

Artificial Intelligence (AI) and Machine Learning (ML)

- **Artificial intelligence (AI)** is a way to make computers smart and able to do things that normally only humans can do, like learning, figuring things out, and making choices.

- **Machine learning (ML)** is a subset of AI that involves the use of algorithms and statistical models to enable computers to learn and improve their performance on a specific task without being explicitly programmed. ML algorithms are trained using large datasets and can make predictions or take actions based on the patterns and trends identified in the data.

These technology trends, such as artificial intelligence (AI) and machine learning (ML), are being used in a variety of industries to improve efficiency and decision-making. Artificial intelligence (AI) and machine learning (ML) are being used in a variety of industries to improve efficiency and decision-making.

Some examples of how AI and ML are helping include:

*Healthcare***:** AI and ML are being used to analyze medical records, predict patient outcomes, and assist with diagnosis and treatment planning.

*Finance***:** AI and ML can help to analyze financial data, identify trends and patterns, and make investment recommendations.

Retail: AI and ML can help in personalizing customer experiences, optimizing pricing and inventory management, and improving supply chain efficiency.

Manufacturing: AI and ML can also improve production processes, reduce defects and downtime, and improve overall efficiency.

Transportation: AI and ML are being used to enhance routes, reduce fuel consumption, and improve safety in the transportation industry.

Agriculture: One can use AI and ML to optimize crop management, improve yields, and reduce waste.

Education: AI and ML will be able to personalize learning experiences, assess student progress, and provide customized feedback.

In short, AI and ML are helping to improve efficiency and decision-making in a variety of industries and are expected to continue to play a significant role in the future.

Internet of Things (IoT)

The **Internet of Things (IoT)** refers to the growing network of physical objects connected to the Internet that can communicate with each other and share data. These connected devices can range from simple sensors to more complex devices such as appliances, vehicles, and industrial equipment. The usage of IoT is one of the emerging technology trends in the electronics and software industry that is revolutionizing the entire human behavior of using technology.IoT devices can collect and transmit data, and they can be controlled and accessed remotely through the internet. This allows for the creation of new products and services that rely on connectivity and data sharing.

5G

The deployment of 5G networks, a key technology trend, is expected to accelerate in the coming years, bringing faster speeds and lower latency to mobile devices. 5G, a significant technology trend, is the fifth generation of mobile network technology that is designed to provide faster speeds and more reliable connections than previous generations. It is a wireless technology that operates in the millimeter wave frequency band, which allows it to transmit data at high speeds over short distances.

Some of the key features of 5G include:

High speed: 5G networks are now much faster than previous generations, with peak speeds of up to 20 Gbps (gigabits per second). This means that 5G networks can transmit data much faster than 4G networks, making it possible to download and stream high-definition video, play online games, and use other data-intensive applications without experiencing delays or interruptions.

Lower latency: Latency is the time it takes for a signal to travel between a device and a network. 5G networks have significantly lower latency than previous generations, with an average latency of around 1 millisecond. This means that 5G networks can respond to requests much faster, making them ideal for applications that require real-time interactions, such as remote surgery or self-driving cars.

More *capacity*: 5G networks can support many more devices than previous generations, thanks to their use of advanced technologies such as beamforming and massive MIMO (multiple input, multiple outputs). This makes 5G ideal for use in crowded areas, such as sports stadiums or city centers, where many devices are competing for network resources.

*Increased reliability***:** 5G networks are designed to be more reliable than previous generations, with lower rates of dropped calls and lost connections. This makes them ideal for use in mission-critical applications, such as emergency services or industrial automation.

Virtual and Augmented reality (VR/AR)

Augmented reality (AR), and **Virtual reality (VR)**, pivotal technology trends, are advanced computer technologies that have multiple uses such as gaming, education, and healthcare. VR creates a computer-generated world that a person can experience as if they were there, while AR adds computer-generated images to a person's view of the real world. Both have a wide range of applications and are expected to continue to grow in industries and applications in the future. VR has already been used for gaming, education, training, and entertainment, and will likely continue to expand.

AR has also been used for enhancing the real world with additional information, and will likely continue to be developed and used in new ways. VR and AR also have potential in remote work and communication, as they can create immersive virtual environments for people to work and interact with each other remotely. In 2019, 14 million AR and VR gadgets were sold.Both VR and AR will likely continue to be used in a variety of industries and applications in the year 2023. VR has already been used for a wide range of purposes, including **gaming, education, training, and entertainment, and these applications will likely continue to expand.**

Robotic Process Automation (RPA)

Like AI and VR/MR, Robotics, a notable technology trend, is being developed for a wide range of applications, including manufacturing, healthcare, and transportation. **Robotic Process Automation (RPA)** is a type of technology that allows organizations to automate repetitive, rule-based tasks by creating digital workers or software robots to perform them. RPA is designed to improve efficiency, reduce errors, and free up human workers to focus on more complex and value-added tasks.

We currently haven't yet processed how big RPA or Robotic Process Automation will become in 2023 as it depends on a variety of factors such as advancements in RPA software and the adoption of these technologies by organizations. However, RPA will likely continue to be a trending technology in 2023 as more and more organizations seek to improve efficiency and reduce costs through automation.One potential area of growth for RPA is in the **field of business process outsourcing (BPO)**. Many BPO providers are already using RPA to automate repetitive tasks and improve efficiency, and this trend will likely continue in the coming years.

Blockchain

The use of blockchain technology, a significant technology trend, is expected to continue to grow in 2023 and years after that, with potential applications in areas such as supply chain management, finance, and other areas. It is difficult to predict with certainty whether blockchain technology will "rule" in 2023 or not, as the adoption and use of blockchain technology depend on a variety of factors such as market demand, regulatory environment, and the availability of supporting infrastructure.But blockchain technology will likely continue to be an important and influential technology in 2023. As you know, Blockchain is a distributed ledger technology that allows for the secure and transparent recording of transactions, and it has the potential to transform a wide range of industries by improving transparency, security, and efficiency.

Here are the top roles in blockchain:

- Blockchain Developer
- Blockchain Solutions Architect
- Blockchain Consultant
- Smart Contract Developer
- Blockchain Project Manager

Quantum Computing

Quantum computing a notable technology trend, is an emerging technology that uses quantum-mechanical phenomena to process data. It is different from classical computing which uses bits; quantum computers use qubits. In comparison to classical computers, they are much faster at performing some tasks.Quantum computers have the **potential to revolutionize fields such as materials science, drug discovery, and financial modeling.** It is still in the early stages of development and has several technical challenges to overcome before it can be widely used. Many companies like **Splunk, Honeywell, Microsoft, AWS, Google,** etc are working on developing quantum computing technology. The market for quantum computing is expected to generate over $2.5 billion in revenue by 2029. Having experience in quantum mechanics, linear algebra, probability, information theory, and machine learning is helpful to be successful in this field.

Datafication

Datafication a key technology trend, is the process of making data easy to understand and use by collecting, organizing, and presenting it in a visual way. This can include creating charts, graphs, or other visualizations. It helps in making data-driven decisions and communicating

findings to others.It will be an important part of data analysis and decision-making in the future as it helps organizations make better use of their data. In 2023, datafication may involve using more advanced tools for visualization and analysis that can create more interactive and sophisticated presentations.

Here are the top roles in Datafication:

- Data Scientist
- Data Engineer
- Data Visualization Specialist
- Data Analyst
- Chief Data Officer (CDO)

Cybersecurity

Cybersecurity a crucial technology trend, refers to the practices and technologies used to protect computer systems, networks, and devices from cyber threats such as hacking, malware, and data breaches. As the use of technology continues to grow and evolve, so do cybersecurity threats. The importance of cybersecurity is expected to continue to grow as more devices and systems become connected.

Several trends are expected to **shape the future of cybersecurity.** One trend is the **increasing use of cloud computing,** which is the delivery of computing services over the internet. Another trend is the **growth of the Internet of Things (IoT)**, which refers to the increasing number of devices that are connected to the internet, such as smart home appliances, medical devices, and industrial equipment. A third trend is the increasing **use of artificial intelligence (AI) and machine learning in cybersecurity**.

Here are the top roles in cybersecurity:

- Information Security Analyst
- Cybersecurity Engineer
- Chief Information Security Officer (CISO)
- Penetration Tester (or Ethical Hacker)
- Incident Responder (or Incident Response Analyst)

3D Printing

3D printing, a notable technology trend, also known as additive manufacturing, is a process that creates a physical object from a digital model by building it up layer by layer. It has the potential to revolutionize the way we manufacture, design, and think about physical objects.

In the future, 3D printing will likely continue to advance and become more widely adopted, leading to significant changes in the way we produce and consume goods.

Here is the list of some of the top jobs in 3d printing:

- 3D Printing Technician
- 3D Printer Engineer
- 3D Printing Designer
- Additive Manufacturing Specialist
- 3D Printing Materials Scientist

Potential developments include ***wider adoption and integration into manufacturing processes, increased use of bioprinting, greater use in construction, and more advanced materials***. *The future of 3D printing is promising, with potential applications in manufacturing, construction, and healthcare. 3D printing technology is expected to continue to advance in 2023.*

Human Augmentation

Have you heard of human augmentation? It's a significant technology trend where technology is used to enhance our bodies or minds. This can include things like prosthetics, exoskeletons, or even a connection between our brain and a computer!

In the next few years, it's likely that we'll see even more advances in this field. For example, **prosthetics and exoskeletons** might become even better and more easily available, helping people with disabilities do things they couldn't before. **Brain-computer interfaces** might let our brains work with computers directly, making us smarter and more skilled. And augmented reality or virtual reality could change the way we experience the world.

We think that human augmentation has a lot of possibilities to make our lives better. But it's important to think about the ethical side too and make sure it's used in a good way.

Conclusion

In 2023, the top technology trends, such as AI and ML, IoT, VR and AR, Robotics and Automation, and 3D printing, are expected to have a significant impact on various industries and daily life. These technologies have the potential to revolutionize the way we work, communicate, and interact. It's important to stay up to date with these trends and consider their implications. Now is a good time to gain the necessary training in one of these trends and join the industry at an early stage, as the adoption of these technologies is creating opportunities for skilled professionals. Also, in the field of technology, you have to be updated always with the latest technology trends to retain your value in the market.

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