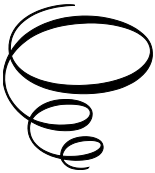
Overcoming Barriers in Technology Innovation Implementation

Overcoming Barriers in Technology Innovation Implementation

By

Davinder Singh

Cambridge Scholars Publishing



Overcoming Barriers in Technology Innovation Implementation

By Davinder Singh

This book first published 2025

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-0364-1832-8
ISBN (Ebook): 978-1-0364-1833-5

I sincerely thank my lovely wife, Navjot Kaur, for her endless support, love, and patience, which have been my greatest source of strength throughout this journey.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The journey of bringing this book, *Overcoming Barriers in Technology Innovation Implementation*, to fruition has been one of immense learning and collaboration. I am deeply grateful to all those who have contributed to its completion.

First and foremost, I extend my heartfelt gratitude to my father, S. Jagroop Singh, my younger brother, Mr. Gurwinder Singh, and other family members for their unwavering support and encouragement throughout this endeavor. Their patience and understanding have been my source of strength.

I am sincerely thankful to my colleagues and mentors at Punjabi University, Patiala, for their guidance and valuable insights that shaped the foundation of this work. Their intellectual contributions and constructive feedback were instrumental in refining my thoughts and research.

I am profoundly grateful to the editors of this book, whose meticulous attention to detail and thoughtful suggestions significantly enhanced its quality. Their expertise and dedication have been invaluable in bringing this work to its final form.

I also wish to acknowledge Cambridge Scholars Publishing for believing in this work and for their professional support throughout the publication process.

Finally, this book is dedicated to all those working tirelessly to innovate and overcome barriers in technology implementation. It is my hope that this work will serve as a resource and inspiration for researchers, practitioners, and organizations striving for meaningful progress in this field.

Davinder Singh

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Micro, Small, and Medium Enterprises (MSMEs) are crucial to fostering economic growth across countries at all stages of development—whether less developed, developing, or developed (Nganga, 2011). These enterprises are globally acknowledged as key drivers of economic advancement, playing a central role in generating employment, spurring innovation, and stimulating local economies.

In different regions, MSMEs may also be known as Small and Medium Enterprises (SMEs) or Small and Medium-Sized Businesses (SMBs) (Adukia, 2012). Despite the variation in terminology, their importance remains consistent. They are often viewed as the backbone of the economy, contributing significantly to job creation, industrial diversification, and overall economic resilience.

Small and Medium Enterprises (SMEs) are fundamental to the structure and growth of economies across the globe. They significantly impact various economic factors, including job creation, production output, export activities, poverty reduction, economic empowerment, and overall economic development.

In both developed and developing countries, SMEs are pivotal in driving economic progress. They contribute to employment by providing a wide range of job opportunities, thereby supporting livelihoods and reducing unemployment. Additionally, SMEs boost economic output through their production and service activities, which helps stimulate economic growth and generate wealth.

SMEs also play a crucial role in fostering export activities, which can enhance a country's trade balance and global economic presence. Their contribution to poverty alleviation is particularly notable in developing countries, where they help reduce poverty by creating jobs and supporting local businesses. This economic activity leads to increased economic empowerment as more people gain access to income and resources.

In developing nations, where poverty and unemployment are particularly pressing challenges, SMEs are especially important. They address these critical issues by providing employment opportunities and fostering economic activity, which can help mitigate the effects of poverty and drive economic development. Overall, SMEs are essential for building a more resilient and inclusive economy, capable of supporting sustainable growth and improving quality of life across diverse economic contexts.

Globally, MSMEs receive support due to their significant impact on productivity growth, which in turn enhances competitiveness and contributes to overall economic expansion. These enterprises are recognized for their role in driving economic progress and increasing the efficiency of various sectors.

Furthermore, MSMEs are highly valued for their effectiveness in job creation. They provide employment opportunities that are crucial for economic stability and development. In addition to creating jobs, MSMEs offer income, training opportunities, and essential basic services to disadvantaged communities. This support helps improve livelihoods, facilitates skill development, and addresses basic needs, thereby contributing to social and economic upliftment (Hussain et al., 2011).

1.2 MSMEs IN INDIA

Micro, Small, and Medium Enterprises (MSMEs) are a cornerstone of the Indian economy, playing a pivotal role in its growth and development. These enterprises are not just a significant component of the business landscape but also a driving force behind economic stability, job creation, and inclusive growth. The importance of MSMEs in India can be understood through various facets, including their contribution to employment, GDP, innovation, and socio-economic development.

- **Employment Generation:** One of the most critical roles of MSMEs in India is their contribution to employment. They are the largest sector in terms of job creation, providing employment to a substantial portion of the workforce. MSMEs offer diverse job opportunities across various skill levels, from low-skilled labor to highly skilled professionals. This sector is crucial for absorbing labor, particularly in rural and semi-urban areas, where larger industries are often sparse. By generating jobs and supporting livelihoods, MSMEs help in reducing unemployment and underemployment, thus contributing to economic stability and social cohesion.
- **Contribution to GDP:** MSMEs are significant contributors to India's Gross Domestic Product (GDP). They are involved in a wide range of activities across sectors such as manufacturing, services, agriculture, and retail. Despite their size, MSMEs contribute a substantial share to the industrial output and overall economic growth. Their ability to operate across various industries and regions makes them a vital part of the economy. The flexibility and adaptability of MSMEs allow them to respond quickly to market changes and economic shifts, further boosting their contribution to GDP.
- **Innovation and Competitiveness:** MSMEs are a breeding ground for innovation and creativity. Their small scale and close-knit operations enable them to experiment with new ideas and technologies more freely than larger corporations. This innovative spirit is crucial for developing new products, services, and processes that drive competitiveness and economic progress. MSMEs often pioneer advancements in technology and business practices, contributing to the overall dynamism of the economy. By fostering innovation, MSMEs help improve productivity and efficiency, enhancing the competitiveness of the Indian economy on a global scale.
- **Support for Local and Regional Development:** MSMEs play a significant role in supporting local and regional development. They are spread across urban and rural areas, contributing to balanced regional development and reducing disparities between different

parts of the country. By setting up operations in less developed areas, MSMEs help in the distribution of economic activity, leading to more even economic growth. This decentralization of economic activities supports infrastructure development and enhances the standard of living in various regions.

- **Socio-Economic Impact;** Beyond economic contributions, MSMEs have a profound socio-economic impact. They support local communities by providing essential services and products, thus improving the quality of life. MSMEs often engage in social initiatives, including providing training and skill development opportunities to disadvantaged groups. This engagement helps in poverty alleviation and promotes economic empowerment among marginalized communities.
- **Challenges and Support:** Despite their importance, MSMEs in India face numerous challenges, including access to finance, inadequate infrastructure, and regulatory hurdles. Recognizing their role, the Indian government has implemented various policies and schemes to support MSMEs, such as the MSME Development Act, financial assistance programs, and infrastructure development initiatives. These efforts aim to address the challenges faced by MSMEs and enhance their growth prospects.

Small industry has been a major component of India's economic development strategy since Independence. With the advent of planned economy in 1951 and the subsequent industrial policies followed by the Government of India, both planners and the government have earmarked a special role for small and medium enterprises in the Indian economy. A high priority was accorded to these enterprises from the very beginning, and the government pursued support policies to make them viable and vibrant. Over time, these enterprises have become major contributors to Gross Domestic Product (GDP) (Kumar et al., 2009). The growth of the small sector is essential for increasing GDP, generating employment, boosting total manufacturing production, and enhancing exports. As one of the fastest-growing economies in the world, India needs to pay close attention to the growth of MSMEs to maximize their contribution in these areas (Singh, 2012).

MSMEs in India are now facing unprecedented opportunities for growth and diversification across a wide range of sectors. The rapidly expanding Indian market provides a fertile ground for entrepreneurs to explore new avenues and scale their businesses. Notable progress has been observed in several industries where Indian MSMEs are making significant strides.

- **Manufacturing and Precision Engineering Design:** In the manufacturing sector, MSMEs are increasingly engaging in advanced production techniques and precision engineering design. These enterprises are leveraging technological innovations to enhance their production capabilities and meet global standards. By adopting new manufacturing technologies and improving efficiency, MSMEs are not only boosting their productivity but also positioning themselves as competitive players in the global market.
- **Food Processing:** The food processing industry is another area where MSMEs are thriving. As consumer preferences shift towards packaged and processed foods, MSMEs are expanding their operations to meet this growing demand. They are involved in various aspects of the food supply chain, including processing, packaging, and distribution. By focusing on quality and innovation, MSMEs in the food processing sector are contributing to the country's food security and creating new market opportunities.
- **Pharmaceuticals:** In the pharmaceuticals sector, MSMEs are playing a crucial role in drug manufacturing and development. These enterprises are involved in producing a wide range of pharmaceutical products, from basic medications to specialized formulations. The growth of the pharmaceutical industry is driven by increasing healthcare needs and advancements in medical research. MSMEs are contributing to this growth by providing affordable and high-quality medicines, thus supporting public health.
- **Textiles and Garments:** The textiles and garments industry is a traditional stronghold for Indian MSMEs. These enterprises are renowned for their expertise in producing a diverse array of textile products, including fabrics, garments, and accessories. With the rise of global fashion trends and increased demand for Indian

textiles, MSMEs are expanding their production capabilities and exploring new markets. Their focus on quality craftsmanship and innovation helps them stay competitive in the international fashion arena.

- **Retail**: The retail sector in India is experiencing rapid growth, and MSMEs are at the forefront of this expansion. From small neighborhood stores to specialized boutiques, MSMEs are catering to a wide range of consumer needs. They are adopting modern retail practices, including e-commerce and digital marketing, to reach a broader customer base. This adaptability allows them to thrive in a dynamic retail environment and contribute to the sector's growth.
- **IT and ITES:** In the IT and IT-enabled Services (ITES) sector, MSMEs are making remarkable progress by offering a range of technology-driven solutions and services. These enterprises are involved in software development, IT consulting, customer support, and various other IT-related services. The growth of the IT and ITES sector is fueled by increasing digitalization and the demand for technology solutions, providing MSMEs with opportunities to innovate and expand their operations.
- **Agro and Service Sectors:** MSMEs are also making significant contributions in the agro sector by engaging in activities such as agro-processing, supply chain management, and agritech innovations. In the service sector, MSMEs are offering diverse services, from healthcare and education to hospitality and logistics. Their involvement in these sectors supports economic diversification and enhances the overall quality of services available to consumers.

Overall, the Indian market's rapid growth and evolving dynamics present MSMEs with numerous opportunities for expansion and diversification. By leveraging these opportunities, Indian MSMEs are not only contributing to economic development but also establishing themselves as key players in various industries. Their adaptability and innovation are driving their success and positioning them for continued growth in the future (Shiralashetti, 2012).

1.3 MSMEs DEVELOPING STRATEGIES IN INDIA

The government's development strategy for small business enterprises in India has evolved around the following key areas:

(i) Protective Discrimination: Measures such as reservation and priority sector lending.

(ii) Integration Between Large and Small Enterprises: Practices such as subcontracting, ancillarisation, and vendor development.

(iii) Institutional Support: Through a network of testing centres, tool rooms, entrepreneurship development institutes, etc.

While the first two decades after Independence focused on institutional support, the third decade saw the introduction of product reservations or exclusive manufacturing in the small sector as the preferred policy intervention. In the fourth decade, the focus shifted to promoting linkages between MSMEs and large units, especially Public Sector Units (PSUs).

In 1991, industrial reforms were initiated on a large scale, and the liberalization of the domestic economy facilitated the establishment of new capacities in large units across various industry segments. Despite a substantial increase in the number of players in each industry segment, the small-scale sector has managed to maintain its position and withstand competition. In some cases, small enterprises have proven to be exceptionally adept at large industrial houses that struggled to respond promptly to changing market needs or innovate in time (Pandey, 2007).

1.4 DEFINITION OF MSMEs

With the passage of the Micro, Small, and Medium Enterprises Development Act in June 2006, various components of this sector were given clear definitions. For the first time, micro enterprises, previously known as the tiny sector, have been formally recognized with a specific definition (investment in plant and machinery up to Rs. 25 lakh). This enhancement is expected to enable these enterprises to pursue technology upgradation and modernization, which are crucial for enhancing competitiveness in the context of liberalization and globalization (Prasad, 2006).

MSMEs are defined differently around the world. Some definitions are based on assets, while others use criteria such as employment, shareholder funds, or sales. Some definitions use a combination of revenue and employment. In India, defining MSMEs has been contentious, but in recent years, the Government of India has worked to provide greater clarity by specifying a clear definition (Srinivasan and Joseph, 2008).

In accordance with the provisions of the Micro, Small, and Medium Enterprises Development (MSMED) Act, 2006, MSMEs are classified into two categories:

(i) Manufacturing Enterprises: These are engaged in the manufacture or production of goods pertaining to any industry specified in the First Schedule to the Industries (Development and Regulation) Act, 1951. Manufacturing enterprises are defined based on investment levels in plant and machinery.

(ii) Service Enterprises: These are engaged in providing or rendering services and are defined based on investment in equipment.

The existing criterion of definition of MSMEs is based on the MSMED Act, 2006. It was different for manufacturing and services units. It was also very low in terms of financial limits. Since then, the economy has undergone significant changes. After 14 years since the MSME Development Act came into existence in 2006, a revision in MSME definition was announced in the Atmnirbhar Bharat package on 13th May, 2020. As per this announcement, the definition of Micro manufacturing and services units was increased to Rs. 1 Crore of investment and Rs. 5 Crore of turnover. The limit of small unit was increased to Rs. 10 Crore of investment and Rs 50 Crore of turnover. Similarly, the limit of medium unit was increased to Rs. 20 Crore of investment and Rs. 100 Crore of turnover. The Government of India on 01.06.2020 decided for further upward revision of the MSME Definition. For medium Enterprises, now it will be Rs. 50 Crore of investment and Rs. 250 Crore of turnover.

The limits for investment in plant and machinery/equipment for manufacturing/service enterprises are detailed in Table 1.1.

Table 1.1: Classification of MSMEs

Classification	**Manufacturing/Service Enterprises***
Micro	Not more than Rs.1 crore and Annual Turnover; not more than Rs. 5 crore
Small	Not more than Rs.10 crore and Annual Turnover; not more than Rs. 50 crore
Medium	Not more than Rs.50 crore and Annual Turnover; not more than Rs. 250 crore

* Investment limit in Plant & Machinery ** Investment limit in equipment
(MSME Annual Report, 2022-23)

The European Union distinguishes between micro, small, and medium-sized businesses based on the criteria shown in Table 1.2.

Table 1.2: Classification of MSMEs in other countries:

Classification	Maximum no. of employees	Maximum annual turnover
Micro	9	2 million Euros
Small	49	5 million Euros
Medium	250	10 million Euros

In the USA, when small businesses are defined by the number of employees, those with fewer than 100 employees are typically considered small, while medium-sized businesses are those with fewer than 500 employees. Both the US and the EU generally use the same threshold of fewer than 10 employees for small offices.

In Canada, the definition of a small business varies by sector: a small business in the goods-producing sector is one with fewer than 100 employees, while in the service sector, it is defined as having fewer than 50 employees. Firms with more employees than these thresholds but fewer than 500 are classified as medium-sized businesses (Pradhan and Munda, 2010).

The Australian Bureau of Statistics (ABS) defines a small business as an enterprise employing up to 99 people. Medium enterprises are those employing between 100 and 199 individuals, while organizations with more than 200 employees are considered large businesses (Jahanshahi et al., 2011).

1.5 ROLE AND IMPORTANCE OF MSME SECTOR IN INDIA

Today, Micro, Small, and Medium Enterprises (MSMEs) are central to the economic development of India. The MSME sector is notably diverse, encompassing a wide range of enterprise sizes, product and service offerings, and technological advancements. This heterogeneity enables MSMEs to play a multifaceted role in the economy, complementing large industries by functioning as ancillary units and contributing significantly to socioeconomic progress.

MSMEs are responsible for approximately 40% of the country's manufactured goods, reflecting their substantial contribution to industrial output. Their role extends beyond production, as they also provide employment to around 59 million individuals. This vast employment generation underscores the sector's importance, positioning MSMEs as the second-largest source of employment in India, following the agricultural sector (Srivastaw and Sadhukhan, 2013).

The employment provided by MSMEs is crucial for several reasons. Firstly, it helps absorb a significant portion of the workforce, particularly in areas where large industries are not prevalent. By creating jobs across various skill levels and regions, MSMEs support economic stability and growth, reduce unemployment, and enhance living standards. The widespread distribution of MSMEs across urban and rural areas also promotes balanced regional development and reduces economic disparities.

In addition to their role in employment generation, MSMEs contribute to the overall dynamism and resilience of the Indian economy. Their ability to adapt quickly to market changes and innovate in response to evolving consumer demands adds to their economic impact. By integrating new technologies and business practices, MSMEs drive productivity improvements and foster competitive advantages within various sectors.

Moreover, MSMEs play a vital role in supporting large industries as ancillary units. They provide essential components, services, and support functions that enhance the efficiency and competitiveness of larger enterprises. This symbiotic relationship strengthens the industrial ecosystem, creating a more robust and interconnected economic framework.

The socioeconomic impact of MSMEs extends to their contribution to local economies. They often engage in community-based initiatives, offer training and skill development opportunities, and support local supply chains. This engagement helps build resilient local economies and promotes inclusive growth, ensuring that economic benefits are distributed more equitably.

Given their significant contributions to manufacturing, employment, and regional development, MSMEs are integral to India's economic strategy. Ensuring their growth and sustainability involves addressing various challenges they face, such as access to finance, infrastructure, and technology. Supporting MSMEs through targeted policies, financial assistance, and capacity-building initiatives is essential for maximizing their potential and enhancing their role in driving economic development.

MSMEs are at the heart of Indian economic development, playing a crucial role in manufacturing, employment, and regional growth. Their diverse nature and significant contributions highlight their importance in the economic landscape, making them a key focus for policymakers and stakeholders aiming to foster inclusive and sustainable development in India.

Increased levels of entrepreneurial activity in MSMEs can significantly impact specific policy outcomes in the following areas:

i) Create Opportunities: Job creation, career development, and new products/services.

ii) Economic Growth: Productivity improvement and innovation.

iii) Poverty Alleviation: Enhancing social opportunities.

iv) Market Expansion: Creating new customers and opening up new

markets (Jahanshahi et al., 2011).

Over the years, the small-scale sector in India has evolved from producing simple consumer goods to manufacturing sophisticated and precision products, such as electronics control systems, microwave components, and electro-medical equipment. The process of economic liberalization and market reforms has exposed these enterprises to increasing levels of domestic and global competition.

In India, Micro, Small, and Medium Enterprises (MSMEs) are responsible for manufacturing a diverse array of over 6,000 products. This broad spectrum of production showcases the sector's extensive involvement in various industries, contributing significantly to the country's manufacturing output. The major subsectors within MSMEs, in terms of manufacturing output, are as follows:

- **Food Products (18.97%):** This subsector leads in manufacturing output among MSMEs. It encompasses a wide range of food items, from processed foods to packaged snacks, reflecting the sector's critical role in addressing both domestic consumption and export demands.
- **Textiles and Readymade Garments (14.05%):** MSMEs in this subsector are integral to India’s vibrant textile and garment industry. They produce a variety of textiles, apparel, and accessories, catering to both domestic markets and international fashion trends.
- **Basic Metals (8.81%):** This subsector includes the production of essential metal products, such as steel and iron, which are fundamental for construction, manufacturing, and other industrial applications.
- **Chemical and Chemical Products (7.55%):** MSMEs in this sector manufacture a range of chemical products, including fertilizers, pesticides, and specialty chemicals. Their contributions support agriculture, industry, and everyday consumer products.
- **Metal Products (7.52%):** The production of metal products, including fabricated metal structures and components, is another significant area for MSMEs. These products are used in various

applications, from construction to automotive industries.

- **Machinery and Equipment (6.35%):** This subsector involves the manufacture of machinery and equipment used across different industries. MSMEs produce components and complete machinery that are essential for manufacturing and other industrial processes.
- **Transport Equipment (4.5%):** MSMEs in this category produce transport equipment, including components and vehicles, contributing to the transportation infrastructure and logistics sector.
- **Rubber and Plastic Products (3.9%):** This subsector includes the manufacturing of rubber and plastic goods, ranging from industrial components to consumer products, reflecting the sector's versatility and importance.
- **Furniture (2.62%):** MSMEs are involved in the production of a variety of furniture items, catering to residential, commercial, and industrial needs. This subsector contributes to the country's furniture industry with both traditional and contemporary designs.
- Paper and Paper Products (2.03%): The paper industry, including the production of paper and paper-based products, is another important area for MSMEs. These products are essential for packaging, printing, and various other applications.
- Leather and Leather Products (1.98%): This subsector involves the manufacture of leather goods, including footwear, bags, and accessories. MSMEs contribute to both domestic consumption and export markets in the leather industry.

The diverse range of products manufactured by MSMEs underscores their crucial role in the Indian economy. Their ability to produce such a wide array of goods not only supports domestic industries but also enhances India's position in global markets. By addressing the challenges faced by MSMEs and supporting their growth, India can further leverage this sector to drive economic development and innovation (Adukia, 2012).

1.6 SIZE AND CONTRIBUTION OF MSME SECTOR

The MSME sector has become a vibrant and crucial component of the Indian economy over the past five decades (MSME Annual Report, 2022-

23). With a growth rate surpassing 8%, India is projected to become the world's second-largest economy by 2025. India's share of global merchandise exports grew from less than 0.6% in 2010 to 1.6% in 2020, and the country is also becoming a significant investor in other nations' manufacturing and services sectors (Baral, 2013).

As per data from the Ministry of Micro, Small & Medium Enterprises, as of March 2024, the number of MSMEs registered on the Udyam portal, including the Udyam Assist Platform (UAP), has reached 4,00,42,875, with continual growth observed. Among these, 3,93,18,355 are classified as micro-enterprises, accounting for approximately 97.7% of the total. Small enterprises constitute 6,08,935, representing about 1.5%, while medium-sized enterprises total 55,488, comprising roughly 0.8% of the total registered entities. The number of MSMEs in the country is expected to grow from 6.3 crore, of which only 2.5 crore have ever availed credit from formal sources to approximately 7.5 crore in the coming times.

This sector has consistently outpaced the growth of the broader industrial segment. It is widely recognized that the MSME sector offers the most significant opportunities for both self-employment and job creation, second only to the agricultural sector (Kumar and Sardar, 2011). Table 1.3 illustrates the contribution of MSMEs to GDP.

Table 1.3: Contribution of MSMEs in the Gross Domestic Product [GDP]

Year	% share of Export of MSME related products in All India Export	% share of MSME Gross Value Added (GVA) in all India Gross Domestic Product (GDP)
2019-20	49.77	29.7
2020-21	49.35	30.5
2021-22	45.03	30.48
2022-23	43.59	27.24
2023-24	45.56	29.15

(MSME Annual Report, 2022-23)

The percentage share of MSME Gross Value Added (GVA) in all India Gross Domestic Product (GDP) across India accounted for over 29 percent of India's gross domestic product (GDP) in the financial year 2023-24. This was an increased contribution as compared to the previous year. Additionally, MSMEs account for a significant part of the country's exports.

1.7 GROWTH AND PERFORMANCE OF MSMEs

MSMEs are one of the driving forces propelling the Indian economy towards global greatness. As per the Udayam portal, MSMEs employ over two crore people, firmly establishing themselves as the bedrock of the economy. Aided partly by supportive and reformatory government initiatives and technological innovations, the MSME sector has grown exponentially, accounting for ~46% of India's total exports. The performance of MSMEs can be effectively measured through their ability to generate employment, promote growth, and distribute income levels. Following are some key highlights of the Economic Survey 2023-24:

- In response to the pandemic, India has responded in three components: first, by focusing on public spending on infrastructure; second, by a natural response of business enterprise and public administration amidst adversities, i.e., digitalisation of service delivery; and third, by 'Atmanirbhar Bharat Abhiyan' in terms of targeted relief to different sectors of the economy and sections of the population, and structural reforms that assisted a firm recovery and increased the medium-term growth potential.
- India's real GDP grew by 8.2% in FY24, posting growth of over 7% for a third consecutive year, driven by stable consumption demand and steadily improving investment demand.
- Gross value added (GVA) at 2011-12 prices grew by 7.2% in FY24, with growth remaining broad-based.
- Net taxes at constant (2011-12) prices grew by 19.1% in FY24, aided by reasonably strong tax growth, both at the centre and state levels and rationalisation of subsidy expenditure. This led to the difference between GDP and GVA growth in FY24.

- The shares of the agriculture, industry and services sector in overall GVA at current prices were 17.7%, 27.6% and 54.7%, respectively in FY24.
- Within the industrial sector, manufacturing GVA grew by 9.9% in FY24 as compared to FY23 (Economic Survey 2023-24).

1.8 TECHNOLOGY INNOVATION

It is impossible to discuss the current level of societal development without considering the concept of innovation. While the link between economic growth, progress, development, and innovation is a relatively recent perspective, innovation itself has been present since the dawn of humanity. We are constantly surrounded by the results of innovations that have evolved throughout history. Thinking differently, striving for improvement, and seeking better ways of doing things are inherent characteristics of human beings, deeply rooted in intelligence and creativity. For a long time, innovation was applied in a simple, rudimentary form, influenced only by individual skills and capabilities. However, today, innovation is viewed in a broader context, where there is an opportunity to educate, train, and enhance innate innovative talent.

Our development is now closely tied to and dependent on the ability to promote, sustain, and apply innovation across all sectors of society. This underscores the importance of studying innovation to identify effective ways to implement and leverage it for economic growth and societal well-being. The systematic study of innovation began after the Austrian economist Joseph A. Schumpeter introduced a novel approach emphasizing innovation's impact on economic development. Schumpeter viewed innovation as the driving force behind qualitative changes across all areas of society, achieved by recombining or utilizing existing resources in new ways. He identified five key forms of innovation:

- A new product or an improved version of an existing product.
- A new production method or sales approach not previously used.
- A new market.
- A new source of raw materials or semi-finished goods.
- A new form of business organization.

These areas, as defined by Schumpeter, demonstrate that innovation is not confined to industry but can be applied across all sectors of an economy. Even though Schumpeter's theory is over a century old, it remains relevant today as it highlights that entrepreneurial activities aimed at profit should be grounded in innovation for future growth. Schumpeter, often called "the prophet of innovation," foresaw the critical role of innovation in business and the broader economy.

To succeed, entrepreneurs must allocate available resources in new ways or combinations so that the final product or service can:

- Meet new demands,
- Address unmet needs,
- Respond to traditional customs and market needs in innovative ways.

Technology innovation is a broad and dynamic field that encompasses various forms and approaches to creating new products, processes, and services. These innovations can be classified into different types based on their nature, impact, and application. Understanding the different types of technology innovation is essential for businesses, policymakers, and researchers to effectively harness the power of innovation for growth and development. This essay explores the major types of technology innovation, including incremental, disruptive, radical, and architectural innovations, and examines their implications and examples.

1.8.1 Incremental Innovation

Incremental innovation refers to the continuous improvement and enhancement of existing products, services, or processes. This type of innovation focuses on making small, gradual changes that enhance functionality, efficiency, or user experience. Incremental innovation is often driven by customer feedback, technological advancements, and competitive pressures.

- **Smartphones:** The evolution of smartphones is a classic example of incremental innovation. Each new model of a smartphone

typically includes improvements in camera quality, battery life, processing power, and software features, while maintaining the core functionality of the device.

- **Automotive Industry:** In the automotive industry, incremental innovations can be seen in the continuous improvement of fuel efficiency, safety features, and infotainment systems. For instance, the addition of adaptive cruise control or lane-keeping assist in newer car models represents incremental innovations that enhance the driving experience.

1.8.2 Disruptive Innovation

Disruptive innovation, a concept popularized by Clayton Christensen, refers to innovations that create new markets by offering simpler, more affordable, or more accessible products and services, often displacing established competitors. Disruptive innovations typically start in niche markets or lower-end segments but gradually move upmarket, challenging incumbent firms.

- **Digital Photography:** The shift from film-based photography to digital photography is a prime example of disruptive innovation. Initially, digital cameras were inferior in quality compared to traditional film cameras and were mostly used by hobbyists. However, as digital technology improved, it disrupted the entire photography industry, leading to the decline of film-based cameras and companies like Kodak.
- **Ride-Sharing Services:** Companies like Uber and Lyft have disrupted the traditional taxi industry by offering a more convenient, cost-effective, and user-friendly alternative. These platforms leveraged mobile technology to connect drivers and passengers directly, bypassing the need for traditional taxi services.

1.8.3 Radical Innovation

Radical innovation involves the development of entirely new products, services, or processes that represent a significant departure from existing technologies or practices. Radical innovations often create new industries

or transform existing ones by introducing groundbreaking technologies or business models.

- **The Internet:** The invention and commercialization of the internet is a radical innovation that has fundamentally transformed the way people communicate, access information, and conduct business. It gave rise to entirely new industries, such as e-commerce, online advertising, and social media, while disrupting traditional industries like print media and retail.
- **Genetic Engineering:** The development of genetic engineering techniques, such as CRISPR-Cas9, represents a radical innovation in the field of biotechnology. These techniques have opened up new possibilities for medical treatments, agriculture, and bioengineering, with the potential to address some of the most pressing challenges in health and food security.

1.8.4 Architectural Innovation

Architectural innovation involves the reconfiguration of existing technologies or components to create new systems or products. Unlike radical innovation, which introduces entirely new technologies, architectural innovation focuses on how existing technologies are integrated and combined in novel ways. This type of innovation often leads to significant improvements in performance, efficiency, or functionality.

- **Personal Computers (PCs):** The development of the personal computer is an example of architectural innovation. While the individual components of a PC, such as the microprocessor, memory, and storage, were not new, their integration into a compact, affordable, and user-friendly system revolutionized the computing industry and made computers accessible to the general public.
- **Smart Home Systems:** Smart home systems, which integrate existing technologies like sensors, Wi-Fi, and mobile apps, represent architectural innovation. By combining these components into a cohesive system, smart home technology allows users to control and monitor various aspects of their home environment,

such as lighting, security, and climate, from a single interface.

1.8.5 Modular Innovation

Modular innovation refers to changes in one or more components of a product or system, without altering its overall architecture. This type of innovation involves improving or replacing specific modules or components to enhance the performance or functionality of the whole system. Modular innovation is common in industries where products are composed of multiple interchangeable parts.

- **Computer Hardware:** In the computer industry, modular innovation is evident in the ongoing improvements to components such as processors, memory, and storage devices. For example, the transition from hard disk drives (HDDs) to solid-state drives (SSDs) represents a modular innovation that significantly improved the speed and reliability of computers without changing their overall architecture.
- **Automotive Components:** In the automotive industry, modular innovation can be seen in the development of new engine technologies, such as hybrid or electric powertrains, which can be integrated into existing vehicle architectures. These innovations improve fuel efficiency and reduce emissions without requiring a complete redesign of the vehicle.

1.8.6 Impact of Technology Innovation on Various Sectors

- **Healthcare:** Technology innovation has had a profound impact on the healthcare sector, improving patient outcomes, increasing access to care, and reducing costs. The rise of telemedicine, for example, has made it possible for patients to consult with healthcare providers remotely, reducing the need for in-person visits and making healthcare more accessible to people in remote areas.

Wearable devices, such as fitness trackers and smartwatches, have empowered individuals to monitor their health in real-time, tracking metrics such as heart rate, physical activity, and sleep patterns. These

devices can also alert users to potential health issues, enabling early intervention and prevention.

Advances in medical imaging, such as MRI and CT scans, have revolutionized diagnostics, allowing for more accurate and non-invasive assessments of medical conditions. Additionally, the development of minimally invasive surgical techniques, such as laparoscopic surgery, has reduced recovery times and improved patient outcomes.

Biotechnology innovations, such as gene editing and personalized medicine, are also transforming healthcare. The CRISPR-Cas9 gene-editing technology has opened new possibilities for treating genetic disorders, while personalized medicine tailors treatments to individual patients based on their genetic makeup. These innovations hold the potential to revolutionize the treatment of diseases such as cancer, diabetes, and heart disease.

- **Manufacturing:** The manufacturing sector has been transformed by technology innovation, particularly through the adoption of Industry 4.0 principles. Industry 4.0 refers to the integration of cyber-physical systems, IoT, and big data analytics into manufacturing processes, creating smart factories that are more efficient, flexible, and responsive to changes in demand.

Automation and robotics have played a central role in this transformation. Robots are increasingly being used in manufacturing to perform tasks that are repetitive, dangerous, or require high precision. Automation has improved productivity, reduced errors, and lowered costs, while also enabling mass customization and shorter lead times.

Additive manufacturing, also known as 3D printing, is another disruptive technology in the manufacturing sector. 3D printing allows for the creation of complex and customized products with greater efficiency and less material waste. This technology is being used in a wide range of industries, from aerospace and automotive to healthcare and consumer goods.

The rise of smart manufacturing has also led to the development of digital twins—virtual replicas of physical assets or processes that can be used for simulation, optimization, and predictive maintenance. By leveraging digital twins, manufacturers can improve the performance of their operations and reduce downtime.

- **Finance:** The financial sector has been profoundly impacted by technology innovation, with the rise of fintech (financial technology) companies challenging traditional banking models and creating new opportunities for consumers and businesses alike. Fintech innovations have revolutionized payments, lending, investment, and financial management, making financial services more accessible, efficient, and transparent.

One of the most significant innovations in finance is blockchain technology, which underpins cryptocurrencies like Bitcoin and Ethereum. Blockchain is a decentralized ledger system that records transactions in a secure and transparent manner. This technology has the potential to disrupt traditional financial systems by enabling peer-to-peer transactions without the need for intermediaries such as banks.

AI and ML are also transforming the finance industry. AI algorithms are being used for tasks such as fraud detection, risk assessment, and customer service, while robo-advisors provide personalized investment advice based on individual financial goals and risk tolerance. Additionally, AI-powered trading systems are increasingly being used to execute trades at high speeds and with greater accuracy.

The rise of mobile banking and digital wallets has further transformed the way people manage their finances. Mobile banking apps allow users to conduct transactions, check account balances, and manage investments from their smartphones, providing greater convenience and accessibility. Digital wallets, such as Apple Pay and Google Wallet, enable secure and contactless payments, reducing the need for cash and physical cards.

- **Education:** Technology innovation is reshaping the education sector, providing new tools and approaches for teaching and learning. The rise of online learning platforms, such as Coursera, edX, and Khan