

Hi-Tech and Emerging Innovative Industries and Pakistan's Policies and Regulations Towards Adaptation in the Light of China's Strategies of Reverse

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Abstract:

High-tech and innovative emerging industries are critical drivers of economic growth and transformation, with applications in fields such as artificial intelligence, renewable energy, electric vehicles, and biotechnology. This paper explores the potential for Pakistan to adapt to these industries by learning from China's reverse engineering strategies and implementing policies that foster innovation and technological development. Key recommendations include increasing investment in research and development (R&D), improving access to STEM talent, upgrading infrastructure, creating a supportive regulatory framework, and enhancing intellectual property protection. By fostering a vibrant entrepreneurial ecosystem and collaborating with global leaders like China, Pakistan can position itself as a competitive player in the global high-tech market. These strategies will help Pakistan leverage its resources and workforce to promote innovation and become a technological hub in the region.

Key words:

High-Tech Industries, Innovation, Reverse Engineering, Research and Development, Pakistan's Economic Growth

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Introduction

High-tech and innovative emerging industries have become increasingly important drivers of economic growth and societal advancement. These industries are characterized by the application of cutting-edge technologies, such as artificial intelligence, electric vehicles (EVs), renewable energy, blockchain technology, and biotechnology, among others, to create new products, services, and business models that transform traditional industries and create entirely new markets. From fintech and e-commerce to clean energy and space exploration, high-tech and innovative emerging industries are reshaping the global economy and offering exciting opportunities for entrepreneurs, investors, and skilled professionals alike. In this context, staying informed about the latest trends, challenges, and opportunities in these industries is essential for anyone interested in innovation, entrepreneurship, and the future of work. According to the World Economic Forum⁸, faster digital connections, powered by 5G and the IoT, have the potential to unlock economic activity. So much so that implementing faster connections in “mobility, healthcare, manufacturing, and retail could increase global GDP by \$1.2 trillion to \$2 trillion by 2030.” 5G and IoT will be among the most-watched tech trends for the next decade. Pakistan's policies and regulations regarding the adaptation of high-tech and innovative emerging industries are crucial for the country's economic growth and development. With China's and Japan's strategies of reverse engineering, it is essential for Pakistan to develop a comprehensive plan for adapting emerging technologies while safeguarding its intellectual property rights.

Pakistan can learn from China's strategies of reverse engineering and adapt them to its own needs. One possible approach is to establish research and development centers in collaboration with Chinese universities and research institutions. These centers can provide training and research opportunities for Pakistani scientists and engineers to gain hands-on experience with emerging technologies. Another approach is to provide incentives for local companies to invest in research and development. This can be achieved by offering tax breaks, subsidies, and other forms of financial support to encourage innovation and entrepreneurship. This will help to create a more favorable environment for foreign companies to invest in Pakistan's emerging industries.

Overall, Pakistan needs to adopt a proactive approach to adapt to high-tech and innovative emerging industries by learning from China's and Japan's strategies of reverse engineering and developing its own policies and

⁸ [Top 10 tech trends for next 10 years \(according to McKinsey\) | World Economic Forum \(weforum.org\)](https://www.weforum.org/agenda/2021/10/technology-trends-top-10-mckinsey/) <https://www.weforum.org/agenda/2021/10/technology-trends-top-10-mckinsey/>

regulations, which will help position Pakistan as a major player in the global economy.

WHAT ARE HIGH-TECH INDUSTRIES?

High-tech industries are those that involve the use of advanced technology and innovative techniques to create or develop new products, processes, or services. These industries typically focus on cutting-edge technologies and products, such as software, semiconductors, electronics, biotechnology, nanotechnology, renewable energy, and advanced manufacturing. High-tech industries often require significant investment in research and development, as well as highly skilled workers with specialized knowledge in science, engineering, and computer programming. They are often associated with rapid innovation, high growth potential, and high profit margins. Gartner⁹ lists five impactful emerging technologies for 2022, such as smart spaces, homomorphic encryption, generative AI, graph technologies, and the metaverse, that will disrupt and transform entire markets.

Examples of high-tech industries include:

- Software development
- Defense
- Biotechnology
- Telecommunications
- Clean technology
- Nanotechnology

WHAT ARE INNOVATIVE INDUSTRIES?

Innovative industries refer to sectors of the economy that are characterized by a high level of technological innovation, creativity, and new product development. These industries are typically at the forefront of research and development, and they often create new products, processes, or services that revolutionize the way we live and work. Forbes¹⁰ lists some of the top six emerging industries to invest in for 2022, such as biotechnology, cybersecurity, e-commerce, renewable energy, virtual reality, and more. Some examples of innovative industries include:

1. Information Technology: This includes companies that produce hardware, software, and services related to computers, mobile devices, and other digital technologies.
2. Life Sciences: This encompasses companies that work with genetics, pharmaceuticals, medical devices, and other healthcare-related technologies.

⁹ [5 Impactful Emerging Technologies for 2022 \(gartner.com\)](https://www.gartner.com/en/articles/5-impactful-technologies-from-the-gartner-emerging-technologies-and-trends-impact-radar-for-2022)

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¹⁰ [2021's Top Six Emerging Industries To Invest In \(forbes.com\)](https://www.forbes.com/sites/forbesbusinesscouncil/2021/04/19/2021s-top-six-emerging-industries-to-invest-in/)

<https://www.forbes.com/sites/forbesbusinesscouncil/2021/04/19/2021s-top-six-emerging-industries-to-invest-in/>

3. Renewable Energy: This includes companies that produce solar, wind, and other clean energy technologies.
4. Aerospace: This encompasses companies that produce aircraft, spacecraft, and other advanced defense technologies.
5. Robotics: This encompasses companies that produce robotics and automation technologies that can improve efficiency, safety, and productivity in various industries.

Overall, innovative industries are critical to driving economic growth and improving our quality of life by introducing new technologies and products that make our lives easier, more productive, and more enjoyable.

WHAT ARE EMERGING INDUSTRIES?

Emerging industries are industries that are in their early stages of development and are expected to grow rapidly in the near future. These industries are typically characterized by innovative technologies, new business models, and changing consumer behavior. Emerging industries often offer new products or services that meet evolving consumer needs and preferences. According to Investopedia,¹¹ emerging industries are a group of companies in a line of business formed around a new product or idea that is in the early stages of development.

Examples of emerging industries include:

1. Artificial intelligence and machine learning: These technologies are being used to develop intelligent systems and devices that can perform tasks without human intervention.
2. Virtual and augmented reality: These technologies are being used to create immersive experiences in gaming, entertainment, and education.
3. E-commerce: This industry is rapidly growing due to the increasing number of consumers shopping online and the growing number of businesses moving their operations online. Overall, emerging industries are typically seen as promising areas for investment and growth, as they have the potential to create new jobs, drive innovation, and generate economic value.

WHAT IS REVERSE ENGINEERING?

Reverse engineering is the process of analyzing a product, system, or technology in order to understand how it works, often with the goal of creating a replica or improving upon the original design. It involves breaking down a product or system into its component parts, studying how

¹¹ [2021's Top Six Emerging Industries To Invest In \(forbes.com\)](https://www.forbes.com/sites/forbesbusinesscouncil/2021/04/19/2021s-top-six-emerging-industries-to-invest-in/)
<https://www.forbes.com/sites/forbesbusinesscouncil/2021/04/19/2021s-top-six-emerging-industries-to-invest-in/>

they are interconnected and how they work together, and then creating a blueprint or design based on that information.

Reverse engineering can be used in a variety of fields, including software engineering, mechanical engineering, and electronics. It is often employed by companies to gain a competitive advantage by learning how their competitors' products work or to improve upon existing designs. It can also be used by researchers and academia to study and understand complex systems. However, reverse engineering can also be used for malicious purposes, such as stealing intellectual property or creating counterfeit products.

Pakistan's policies and regulations towards emerging innovative industries:

Pakistan has implemented various policies and regulations to promote innovation and entrepreneurship in the country. The government launched the "National ICT Policy 2015" to promote the growth of the information and communication technology (ICT) sector. This policy aimed to enhance the competitiveness of the ICT industry by providing a conducive environment for research and development, investment, and innovation. Furthermore, the government launched the "National Industrial Policy 2019" to promote industrialization and increase the contribution of the manufacturing sector to the GDP.

However, despite these policies and regulations, Pakistan lags behind in adapting to emerging innovative industries. The lack of research and development and the absence of a robust intellectual property regime are the primary factors contributing to this gap. Additionally, the absence of skilled labor and weak infrastructure further hinder the growth of high-tech industries in the country.

CHINA'S STRATEGIES OF REVERSE ENGINEERING:

China's strategies of reverse engineering have played a significant role in promoting the growth of its high-tech industries. Reverse engineering involves analyzing and replicating existing products to develop new and improved versions. China has mastered this technique and has been able to produce high-quality products at a lower cost. The Chinese government has implemented various policies to promote reverse engineering, such as providing subsidies for research and development and offering tax incentives for innovative products.

IMPLICATIONS FOR PAKISTAN:

Pakistan can learn from China's strategies of reverse engineering and implement similar policies to promote the growth of its high-tech industries. Pakistan needs to focus on research and development, and its government

should provide incentives for innovative products. Additionally, Pakistan needs to strengthen its intellectual property regime to protect the rights of inventors and promote innovation.

Statement of the Problem

The rapid development of hi-tech and emerging innovative industries has presented a significant challenge for Pakistan in terms of policy and regulation adaptation, particularly in the face of China's successful strategies of reverse engineering. However, while Pakistan has made some efforts to encourage innovation and technology development, its policies and regulations may not be adequately suited to foster growth and competitiveness in these industries, potentially hindering the country's economic progress. Therefore, there is a need to examine and evaluate Pakistan's current policies and regulations towards hi-tech and emerging innovative industries, particularly in comparison to China's successful strategies, in order to identify areas for improvement and suggest potential policy reforms to support the growth of these industries in Pakistan. This study aims to explore the problem of inadequate policies and regulations in Pakistan's emerging industries and their impact on the country's competitiveness, with a focus on the role of China's reverse engineering strategies as a potential benchmark for Pakistan to adapt to.

Situational Analysis of Capacity, Preparedness, and Output of the Hi-Tech Industry and its Contribution to National Economic Development in Pakistan

The hi-tech industry in Pakistan is still in its nascent stage; however, it has shown significant growth potential over the past few years. The industry primarily comprises software development, telecommunications, and IT-enabled services. To conduct a situational analysis of the capacity, preparedness, and output of the hi-tech industry and its contribution to national economic development in Pakistan, we need to analyze the following factors:

1. Capacity:

The capacity of the hi-tech industry in Pakistan is growing, and the government is taking various measures to promote the industry. The number of companies in the sector has increased over the years, and there has been a significant rise in the number of IT graduates. However, there is still a need to develop the skills of the workforce to meet the increasing demand for hi-tech services. Additionally, there is a need to increase investment in the sector to enhance its capacity. According to McKinsey¹², based on demographics alone, Pakistan's start-up ecosystem should already have been thriving for many

¹² [*Start-ups in Pakistan: The ecosystem \(finally\) takes off | McKinsey*](#)

years. It has, for starters, the fifth-largest population in the world, approaching 230 million. That population is overwhelmingly young, with a median age of 22, and bilingual, with the fourth-largest number of English speakers in the world. Add to that one of the fastest-growing middle classes, more than 100 million mobile broadband subscribers, and hundreds of thousands of tech professionals, and you have all the makings of a fertile market for new enterprises and digital services.

Yet, until recently, venture or growth funding in Pakistan was barely a trickle compared to similar countries in the Middle East/North Africa region or other parts of Asia. In the last couple of years, however, global VCs and other foreign investors have begun making significant bets on local start-ups as many regulatory and cultural barriers have started to soften.¹³

2. **Preparedness:**

The preparedness of the hi-tech industry in Pakistan is moderate. The government has launched various initiatives to promote the industry, such as the establishment of IT parks and incubators, and the provision of tax incentives for IT companies. However, the industry still faces challenges in terms of infrastructure, regulations, and security. The infrastructure in the country needs to be improved, particularly regarding electricity and internet connectivity. There is also a need to develop a regulatory framework that encourages investment and protects intellectual property rights. Moreover, security concerns, particularly cybercrime, are also challenges that need to be addressed. Pakistan is banking on the new tech zones to create employment for its masses of young people – nearly two-thirds of its population is below 30.¹⁴ Similarly, according to a report by a renowned science website,¹⁵ a comprehensive program has been launched to build a knowledge-based economy by integrating science and technology with economic development programs. The government has raised its financial commitment to the ministry to more than Rs. 7 billion (US\$120 million; a 6000% increase).

3. **Output:**

The output of the hi-tech industry in Pakistan is growing steadily. The industry has contributed significantly to the country's economy and has the potential to contribute even more in the future. According to the Pakistan Software Export Board, the software and IT-enabled services sector in Pakistan has grown at a compound

¹³ [Start-ups in Pakistan: The ecosystem \(finally\) takes off | McKinsey](#)

¹⁴ <https://www.bloomberg.com/news/articles/2021-06-23/pakistan-aims-to-double-it-industry-in-two-years-with-tech-zones>

¹⁵ <https://www.science.org/content/article/science-and-technology-pakistan-way-forward>

annual growth rate of 16.5% over the last five years, and exports have grown at a rate of 23% per year over the same period. In addition, the industry has created employment opportunities for a large number of people, particularly in urban areas. According to a report by Forbes, Pakistan has 300 IT/ITeS organizations and 13,000 registered companies.¹⁶ The "State of Manufacturing in Pakistan" report by ResearchGate shows that Pakistan's manufactured exports in high-tech industries enjoyed higher growth in 2011-22 than in 2000-2010.¹⁷ The World Intellectual Property Organization (WIPO) report shows that Pakistan performs above the regional average in four pillars: Institutions; Business sophistication; Knowledge and technology outputs; and Creative outputs.¹⁸

4. Contribution to National Economic Development:

Despite its limited capacity and preparedness, the hi-tech industry in Pakistan has the potential to make a significant contribution to the country's economic development. The industry can create high-paying jobs, generate foreign exchange earnings, and attract investment. Additionally, the hi-tech industry can play a crucial role in improving the country's overall competitiveness and promoting innovation across different sectors. The hi-tech industry is part of the industrial sector in Pakistan, which contributes nearly Rs. 50 billion (US\$220 million) to the national exchequer. The sector as a whole provides employment to 3.5 million people and plays a pivotal role in promoting the growth of the vendor industry.¹⁹

Overall, the hi-tech industry in Pakistan has the potential to make a significant contribution to the country's economic development. However, there is a need to address the challenges faced by the industry and to invest in infrastructure and skills development to enhance the capacity of the sector. The government needs to develop a comprehensive strategy that addresses the challenges faced by the industry and provides a conducive environment for investment and growth.

¹⁶ [What Special Technology Zones Mean For Pakistan's Tech Industry \(forbes.com\)](https://www.forbes.com/sites/forbestechcouncil/2022/05/31/what-special-technology-zones-mean-for-pakistans-tech-industry/)

<https://www.forbes.com/sites/forbestechcouncil/2022/05/31/what-special-technology-zones-mean-for-pakistans-tech-industry/>

¹⁷ [The State of Manufacturing in Pakistan \(researchgate.net\)](https://www.researchgate.net/publication/308618484_The_State_of_Manufacturing_in_Pakistan)

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¹⁸ [PAKISTAN \(wipo.int\)](https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/pk.pdf)

https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/pk.pdf

¹⁹ https://en.wikipedia.org/wiki/Industry_of_Pakistan

Situational Analysis of Capacity, Preparedness, and Output of the Hi-Tech Industry and its Contribution to National Economic Development in the Context of China

A situational analysis of the hi-tech industry in China involves assessing its capacity, preparedness, and output, as well as its contribution to national economic development.

1. Capacity:

China has a strong capacity in the hi-tech industry, backed by a large pool of skilled labor, research and development facilities, and advanced technology infrastructure. The country has a vast network of universities, research institutions, and industrial parks that specialize in different areas of the hi-tech industry, such as electronics, biotechnology, and software development. China has also invested heavily in science and technology, with the government allocating significant resources to support research and development in key sectors. According to ScienceDirect,²⁰ the technological innovation capability of China's high-tech industries over 2010–2019 was measured using factor analysis. Moreover, the spatial pattern and evolution characteristics of the technological innovation capability of high-tech industries were analyzed using the Moran index. According to the World Bank,²¹ promoting innovation and market competition are key to China's future growth. China's economy is shifting from high-speed growth to high-quality development. It needs to rely on deeper reform, a higher level of opening up, and more integrated and efficient innovation to boost productivity and build a modern economic system. In the 2022 edition of the Global Innovation Index, China ranks 14th in innovation capacity.²²

2. Preparedness:

The Chinese government has shown strong commitment to developing the hi-tech industry and promoting innovation. The government has implemented various policies and initiatives, such as the "Made in China 2025" plan, which aims to transform China into a leading hi-tech manufacturing powerhouse. Additionally, China has set up several national innovation centers and established partnerships with international companies to foster innovation and technology transfer. The country has also prioritized intellectual property protection and enacted laws and regulations to safeguard

²⁰ <https://www.sciencedirect.com/science/article/pii/S2444569X22001226>

²¹ <https://www.worldbank.org/en/news/press-release/2019/09/17/promoting-innovation-and-market-competition-are-key-to-chinas-future-growth>

²² http://www.china.org.cn/business/2023-03/31/content_85203146.htm

against technology theft and infringement. According to the World Economic Forum,²³ China is investing heavily in research and development, with spending in the area 70% higher in 2017 than in 2012. It's also investing in high-tech industrial parks and incubators focusing on technologies such as artificial intelligence, robotics, and big data. Another article by the World Economic Forum²⁴ discusses how China is the second-largest spender on research and development (R&D) after the US, accounting for 21% of the world's total of nearly \$2 trillion in 2019. China's spending on R&D grew by an average of 18% per year between 2010 and 2015 – more than four times faster than US spending.

An article by UC San Diego²⁵ discusses how the Chinese have a new science and technology 2030 innovation plan as well, with a range of innovation-driven development strategies being rolled out under the innovation umbrella. According to the Harvard Business²⁶ Review, China is now on the global frontier of AI in terms of technological development and market applications. The unique technological, market, and policy environments that have emerged in China have enabled it to become a leader in AI.

3. **Output:**

The hi-tech industry is a significant contributor to China's economic growth, accounting for a considerable share of the country's GDP. China has emerged as a global leader in several areas of the hi-tech industry, such as telecommunications equipment, computers, and consumer electronics. The country is also making significant strides in emerging technologies, such as artificial intelligence and biotechnology. The hi-tech industry has created millions of jobs, and its output has helped to drive economic development across the country. According to WIPO,²⁷ China's high-tech trade exports amounted to USD 733.4 billion in 2020, up by 2.3% from USD 716.6 billion in 2019, and more than 20 times the value of its shipments in 2000, which were USD 31.9 billion. An article by JSTOR²⁸ discusses how a high-tech industrial base has been established in China over the past four decades, during which the cumulative investment in high-tech fields and their industries has exceeded RMB 100 billion. In 1987, the gross value of high-tech industrial output accounted for more than RMB 76 billion and amounted to 4.8% of GNP for that

²³ <https://www.weforum.org/agenda/2019/10/china-economy-anniversary/>

²⁴ <https://www.weforum.org/agenda/2018/02/these-charts-show-how-china-is-becoming-an-innovation-superpower/>

²⁵ <https://chinafocus.ucsd.edu/2020/12/14/a-new-era-of-chinese-technology-and-innovation/>

²⁶ <https://hbr.org/2021/02/is-china-emerging-as-the-global-leader-in-ai>

²⁷ https://www.wipo.int/pressroom/en/news/2021/news_0001.html

²⁸ <https://www.jstor.org/stable/2645042>

year. Similarly, an article by Statista²⁹ shows that in 2021, the sales revenue of electronics and communication high-tech companies in China amounted to over RMB 5.48 trillion. In the same year, over 224.6 thousand new products were launched by high-tech companies in China.

4. Contribution to National Economic Development:

The hi-tech industry plays a critical role in China's national economic development. It has helped to drive economic growth, create jobs, and enhance the country's global competitiveness. The industry has contributed to China's transition from a low-cost manufacturing hub to a high-tech innovation hub. It has also supported the country's efforts to move up the value chain and reduce its reliance on exports of low-end products. The government has recognized the importance of the hi-tech industry to the country's economic development and has made it a top priority in its development plans. According to McKinsey,³⁰ digital China is powering the economy to global competitiveness. The impact of digital China on the global economy has been increasing. China ran an annual surplus in digital services of \$10 billion to \$15 billion over the past five years.

In conclusion, China's hi-tech industry has a strong capacity, preparedness, and output, which have contributed significantly to the country's economic development. The government's commitment to innovation and technology transfer has helped to build a vibrant hi-tech ecosystem that has attracted both domestic and international investments. As the industry continues to grow and evolve, it is likely to play an even more prominent role in China's economic development in the coming years.

SITUATIONAL ANALYSIS OF REVERSE ENGINEERING STRATEGIES IN THE SIX MOST IMPORTANT SECTORS OF CHINA AND JAPAN FOR THE DEVELOPMENT OF THE HI-TECH INDUSTRY IN THEIR COUNTRIES AND LESSONS FOR PAKISTAN

Reverse engineering is a process of analyzing and dissecting an existing product or system to understand its design and functionality. This information can then be used to improve or develop similar products or systems. Reverse engineering has played a significant role in the development of the hi-tech industry in China and Japan. According to the *Georgetown Journal of International Affairs*,³¹ Chinese planners outlined

²⁹ <https://www.statista.com/statistics/234389/high-tech-industry-revenue-in-china-by-branch/>

³⁰ <https://www.mckinsey.com/featured-insights/china/digital-china-powering-the-economy-to-global-competitiveness>

³¹ <https://gjia.georgetown.edu/2021/06/22/rethinking-chinas-strategy-of-technological-independence/>

strategies to boost the country's technological capacity; the Made in China 2025 plan, unveiled in 2015, entailed an array of industrial policies to facilitate the development of Chinese firms' competencies in ten strategic industries. Similarly, according to *McKinsey*,³² China's digital development has massive scope for efficiency gains, as the industrial internet of things (IIoT) is deployed at scale to transform digital manufacturing, digital supply chain development, and blockchain-based inventory management.

Here is a situational analysis of reverse engineering strategies in six important sectors of these countries and lessons for Pakistan:

1. Electronics Sector:

China: China has become the world's largest electronics producer, with a focus on reverse engineering strategies. The country has a vast pool of low-cost labor, enabling the mass production of electronics. The government also provides incentives to foreign companies to transfer technology to China. In the electronics sector, China has been focusing on developing its domestic industry through a combination of investment in R&D, acquisitions of foreign technology, and reverse engineering. The country has become a major producer of consumer electronics and has developed a significant semiconductor industry. China's electronic information industry includes computer-related goods (including software), communication equipment, electronic parts, and household entertainment equipment. Major Chinese electronics companies include BOE, Changhong, DJI, Haier, Hisense, Huawei, Konka, Lenovo (Hong Kong based), Meizu, Panda Electronics, Skyworth, SVA, TCL, Xiaomi, Oppo, and ZTE. China's production recorded the largest world market share for its electronics exports in 2016. In 2020, the revenue of consumer electronics in China amounted to over 150 billion U.S. dollars.³³

Japan: Japan, on the other hand, has a strong focus on R&D, which has enabled it to develop high-quality electronic products. Both countries have invested heavily in education and research institutions, which have created a talent pool for the industry. Japan's electronics industry has historically been a leader in innovation and has developed many of the technologies that are now used worldwide. The country has a strong focus on R&D, which has helped to maintain its position as a leading producer of high-tech electronics. Japan has a many-faceted electronics industry ranging from consumer electronics and computer-guided machine tools in

³² <https://www.mckinsey.com/featured-insights/china/the-future-of-digital-innovation-in-china-megatrends->

³³ <https://www.statista.com/forecasts/1240303/china-consumer-electronics-market-revenue>

the 1970s and 1980s to semiconductors, computers, and computer peripherals in the 1990s and beyond.³⁴ Major Japanese electronics companies include Akai, Brother, Canon, Casio, Citizen, Fujifilm, Fujitsu, Hitachi, JVCKenwood, Konica Minolta, Kyocera, Mitsubishi Electric, NEC, Nikon, Nintendo, Olympus, Onkyo, Panasonic, Pioneer, Ricoh, Seiko Group, Sharp, Sony, TDK, Toshiba, and Yamaha.³⁵ Japan has become the largest exporting country of electronics goods to the rest of the world.³⁶ The Japanese consumer electronics industry experienced rapid economic growth in the 1950s. In the decades that followed, Japan was one of the leading nations both in terms of patent applications and technological innovation.³⁷ **Lessons for Pakistan:** Pakistan can learn from China and Japan's success in the electronics sector by investing in R&D and encouraging the development of a domestic industry through partnerships with foreign companies. Japanese electronics were the first products to enter the Pakistani market since the very inception of Pakistan, and later on, the same market was captured by cheap Chinese products. In this way, our engineers are quite familiar with these technologies and they can easily reverse engineer Japanese and Chinese electronics.

2. Automotive Sector:

China: In the automotive sector, China has focused on reverse engineering foreign models to develop its domestic industry. The country has become the world's largest producer of electric vehicles and is a major exporter of automobiles. China is the largest automotive market in the world by both annual sales and manufacturing output.³⁸ The automotive industry in China has been the largest in the world measured by automobile unit production since 2008.³⁹ The total volume of automobile industry sales in China reached 26.2 million units in 2021.⁴⁰ China remains the world's largest automotive manufacturing country and automotive market since 2009.⁴¹

³⁴

<http://crosscurrents.hawaii.edu/content.aspx?lang=eng&site=japan&theme=work&subtheme=INDUS&unit=JWORK063>

³⁵ https://en.wikipedia.org/wiki/Electronics_industry_in_Japan

³⁶ <https://www.eubusinessinjapan.eu/library/publication/report-japanese-electronics-sector>

³⁷ <https://www.statista.com/topics/6624/consumer-electronics-industry-in-japan/>

³⁸ https://en.wikipedia.org/wiki/Automotive_industry_in_China

³⁹ https://en.wikipedia.org/wiki/Automotive_industry_in_China

⁴⁰ <https://www.statista.com/topics/1100/automobile-sales-in-china/>

⁴¹ <https://www.statista.com/topics/1050/automobile-manufacturing-in-china/>

Japan: Japan has been a leader in the automotive industry for decades and has developed a strong reputation for quality and innovation. The country's focus on R&D and investment in new technologies has helped it maintain its position as a leader in the industry. The automotive industry in Japan is an essential pillar of Japan's economy. Companies like Toyota, Honda, and Nissan are industry leaders not only domestically but also globally.⁴² The automotive sector in Japan is the third-largest automotive producing industry in the world, with 78 factories in 22 prefectures and employing over 5.5 million people.⁴³ The industry is worth some 47.3 trillion yen.⁴⁴ State-of-the-art engineering and technology make Japanese cars a desired commodity throughout the world.⁴⁵

Lessons for Pakistan: Pakistan can learn from China's success in the automotive sector by investing in the development of electric vehicles and partnering with foreign companies to develop its domestic industry. Japan's focus on R&D and innovation can also serve as a model for Pakistan to develop its own automotive industry. Pakistan's roads are flooded with Japanese vehicles, and our mechanics have been involved in rectifying their faults for decades. In this way, it's quite easy for Pakistan to reverse engineer Japanese vehicles.

3. Biotechnology Sector:

China: China has been investing heavily in the biotechnology sector and has made significant progress in developing its domestic industry. The country has focused on reverse engineering foreign technology to develop its own capabilities, including the development of its own large domestic biotech industry by replicating foreign drugs' designs and modifying them to suit local needs. China has seen double-digit growth in its biotechnology industry and has gone from being one of the slowest to one of the fastest nations in the adoption of new biotechnologies.⁴⁶ Biotechnology companies originating in China accounted for \$180 billion.⁴⁷ China's biotechnology sector is still too nascent to have produced true giants on the scale of Huawei or Alibaba. Nonetheless, it plays host to several leading global biotechnology firms.

⁴² <https://www.statista.com/topics/3764/automotive-industry-in-japan/>

⁴³ <https://tokyoesque.com/japanese-automotive-market/>

⁴⁴ <https://www.eubusinessinjapan.eu/sectors/automotive>

⁴⁵ <https://www.statista.com/topics/3764/automotive-industry-in-japan/>

⁴⁶ https://en.wikipedia.org/wiki/Biotechnology_industry_in_China

⁴⁷ <https://www.mckinsey.com/industries/life-sciences/our-insights/the-dawn-of-china-biopharma-innovation>

Japan: Japan, on the other hand, has focused on developing cutting-edge technologies and products for the biotech industry. The country has invested in R&D and built partnerships with international players to enhance its biotech industry. Japan has a significant biotechnology industry and has developed its own international market for its biotech products. Japan has a strong biotechnology sector with a market value of about 615 billion yen in 2020. The biotechnology industry in Japan is expected to grow at a CAGR of 6.5% during the forecast period (2020-2025). The Japanese government has been promoting biotechnology as a key industry for economic growth and has been investing heavily in research and development.

Lessons for Pakistan: Pakistan can learn from China's success in the biotech sector by investing in existing R&D institutions and reverse engineering foreign technology to develop its own capabilities. Japan's focus on innovation and new technologies can also serve as a model for Pakistan to develop its own biotech industry.

4. Pharmaceuticals Sector:

China: China has become a major producer of generic drugs and has focused on reverse engineering foreign drugs to develop its own products. The country has also invested heavily in R&D to develop new drugs and treatments. The pharmaceutical industry is one of the leading industries in China. It covers synthetic chemicals and drugs, prepared Chinese medicines, medical devices, apparatus and instruments, hygiene materials, packing materials, and pharmaceutical machinery. China's government has promoted biopharmaceuticals as a key industry since 2015. China-based biopharmas have historically pursued a fast-follower strategy, developing a risk-balanced portfolio heavily weighted in favor of clinically validated targets pioneered overseas.

Japan: Japan has a significant pharmaceuticals industry and has developed many new drugs and treatments. The country's focus on R&D and innovation has helped it maintain its position as a leader in the industry. The pharmaceutical market in Japan has shown small growth rates in recent years. The Japan Pharmaceutical Market is segmented by ATC/Therapeutic Class, Drug Type (Branded and Generic), and Prescription Type (Prescription Drugs (Rx) and OTC). Japan is the third-largest pharmaceutical market in the world and a critical export market for U.S. pharmaceuticals. Since 2013, the Government of Japan ("GOJ") has promoted the healthcare industry as an important growth engine under the country's economic revitalization and growth strategy.

Lessons for Pakistan: Pakistan can learn from China's success in the pharmaceuticals sector by investing in R&D and reverse engineering

foreign drugs to develop its own products. Japan's focus on innovation and new technologies can also serve as a model for Pakistan to develop its own pharmaceuticals industry. There are many pharmaceutical companies working in Pakistan that could reverse engineer Chinese and Japanese medicines quite easily. Similarly, there are many informal sectors involved in making spurious drugs. If the Pakistan government regulates this informal sector and brings them into the mainstream, they can become potential market leaders in reverse engineering.

5. **Robotics Sector:**

China: China has been investing heavily in robotics and has developed its own domestic industry through a combination of investment in R&D and reverse engineering foreign technology. The country has become a major producer of industrial robots and has developed its own humanoid robots. China has been the world's largest market for industrial robotics for almost a decade. In 2020 alone, it installed 140,500 robots, accounting for as much as 44 percent of all installations globally. The sector is expected to grow at a capitalized annual growth rate (CAGR) of 20 percent in the future. Last year, China made robotic industry development a national strategic priority in its 14th Five-Year Plan. The crown jewel of the robotic industry in China today is the intelligent electric vehicle (IEV) industry, which is booming.

Japan: Japan has a significant robotics industry and has developed many new robots for a variety of industries. The country's focus on R&D and innovation has helped it maintain its position as a leader in the industry. Japan is a leader in robotics and uses cutting-edge robotic technologies in various fields besides manufacturing, including service and care-giving robots for the older generation. By 2020, Japan was manufacturing 47% of global robots. Japan employs over a quarter of a million industrial robot workers. In recent years, Japan's robot suppliers have increased their production capacity considerably: Their export ratio rose to 78% in 2020 when 136,069 industrial robots were shipped.

Lessons for Pakistan: Pakistan can learn from China's success in the robotics sector by investing in R&D and reverse engineering foreign technology to develop its own capabilities. Japan's focus on innovation and new technologies can also serve as a model for Pakistan to develop its own robotics industry. Our tech students are already very involved in robot manufacturing and have won certain prizes in global competitions. In this way, Pakistan can easily reverse engineer Japanese and Chinese-manufactured robots and design robots for its domestic as well as foreign use.

6. Renewable Energy Sector:

China: China has become a global leader in the renewable energy sector by using reverse engineering to develop solar panels and wind turbines. Companies like Trina Solar have reverse-engineered foreign-made solar panels and developed their own, leading to lower costs and greater efficiency. China's renewable energy sector is growing faster than its fossil fuels and nuclear power capacity, and is expected to contribute 43 percent of global renewable capacity growth. China is also the world's largest investor in renewable energy, with the country's companies accounting for four of the world's five biggest renewable energy deals made in 2016. In 2017, investments in renewable energy amounted to US\$279.8 billion worldwide, with China accounting for US\$126.6 billion or 45% of global investments. China is set to install a record 156 gigawatts of wind turbines and solar panels this year. Chinese solar-panel manufacturers are estimated to have a 20% cost advantage over their U.S. peers, owing to economies of scale and more advanced supply-chain development.

Japan: Japan has also used reverse engineering to develop renewable energy technologies. Japan has set an ambitious target for renewable energy in the nation's electricity mix by 2030 as it aims to tackle climate change and achieve its 2050 carbon neutrality goal. The country aims for 36-38% of energy to come from renewables by 2030. Hydroelectricity is Japan's main renewable energy source, with an installed capacity of about 27 GW, or 16% of the total generation capacity, of which about half is pumped-storage. The production was 73 TWh in 2010. Japan has seen rapid expansion of solar photovoltaic in recent years, driven by generous feed-in-tariffs. More efforts are needed to develop other renewable technologies, including wind and geothermal, for which Japan's energy potential is large.

Lessons for Pakistan: Pakistan can learn from these examples by investing in renewable

energy and using reverse engineering to develop its own technologies. Pakistan has a huge wind corridor along its coastline, which could be used for the production of renewable energy. We are already using that corridor, and foreign wind turbines are already in place. We just need to reverse engineer that.

Pakistan can learn several lessons from the reverse engineering strategies of China and Japan. The key takeaway is that investing in research and development is critical to fostering innovation in the hi-tech industry. Additionally, developing affordable and efficient products for the domestic market is crucial to developing a thriving hi-tech industry. Finally, using

reverse engineering to analyze and improve existing technologies can lead to lower costs, greater efficiency, and increased competitiveness in the global market.

LEGAL AND INSTITUTIONAL FRAMEWORK OF THE HI-TECH INDUSTRY IN PAKISTAN

Legal Framework

Pakistan has several legal frameworks in place to support and regulate innovative industries. Some of the key legal frameworks are:

1. **Intellectual Property Laws:** Pakistan has strong intellectual property laws in place to protect innovations, inventions, trademarks, copyrights, and patents. The relevant laws include the Patents Ordinance 2000, the Trademarks Ordinance 2001, and the Copyright Ordinance 1962.
2. **Company Law:** Pakistan has a comprehensive company law framework that governs the incorporation, management, and operation of companies. The relevant laws include the Companies Act 2017, which provides a legal framework for the registration, governance, and winding up of companies in Pakistan.
3. **Tax Incentives:** The government of Pakistan offers tax incentives to encourage innovation and entrepreneurship. These incentives include tax holidays, tax exemptions, and tax credits for businesses engaged in research and development. The government is offering a 10-year waiver on corporate tax and imports of any equipment or building material needed for these areas.
4. **Startup Policy:** The government of Pakistan has recently launched a Startup Policy to provide a framework for the development of the startup ecosystem in the country. The policy includes measures to support the creation and growth of startups, including access to finance, mentorship, and incubation services. Pakistan has introduced amendments to the Companies Act and the Private Fund Regulations to facilitate startups and improve their access to finance.
5. **Competition Law:** The Competition Act, 2010 regulates competition in the market and prohibits anticompetitive practices, such as the abuse of dominant positions and mergers and acquisitions that may lead to a significant reduction in competition.
6. **Cyber Laws:** Pakistan has recently amended the Prevention of Electronic Crimes Act, 2016, which addresses cybercrime and provides for the punishment of various offences, such as unauthorized access to data, cyberstalking, and cyberterrorism.

7. **Securities Laws:** The Securities and Exchange Commission of Pakistan (SECP) regulates capital markets and public companies in Pakistan under the Securities Act, 2015.
8. **Labour Laws:** The Industrial Relations Act, 2012 governs the relationship between employers and workers and regulates matters such as collective bargaining and trade unions.
9. **Environmental Laws:** The Environmental Protection Act, 1997, and the Pakistan Environmental Protection Agency (PEPA) regulate the protection of the environment and the conservation of natural resources.
10. **Personal Data Protection:** Additionally, there is a bill being enacted to regulate controllers and processors of personal data in Pakistan. The Personal Data Protection Bill will be the main legislation regulating controllers and processors of personal data in Pakistan. Although the Personal Data Protection Bill (PDPB) has not yet been enacted, it shares similarities and differences with the General Data Protection Regulation (GDPR) of the European Union.

Overall, Pakistan has a range of legal frameworks in place to support and regulate innovative industries, including intellectual property laws, company law, technology parks, tax incentives, and a startup policy. These frameworks provide a supportive environment for businesses engaged in innovation and entrepreneurship in Pakistan.

Institutional Framework

Pakistan has an institutional framework for the hi-tech industry that aims to provide a conducive environment for its development. Here are the key elements of this framework:

1. **Ministry of Industries and Production:** The Ministry of Industries and Production is a federal-level government ministry in Pakistan. Its primary responsibility is to promote industrial development and growth in the country. The ministry is responsible for formulating policies, regulations, and laws related to industry and production, as well as overseeing the implementation of these policies.
2. **Ministry of Science and Technology:** The Ministry of Science and Technology is responsible for promoting scientific research and technological development in Pakistan. The ministry has several institutions under its control, such as the Pakistan Council for Scientific and Industrial Research (PCSIR), which provides R&D services to the industry. The Pakistani government has allowed for the creation of special technology zones, which aim to boost the IT economy of the country. The goal is to double Pakistan's IT industry in two years by setting up dedicated tech zones across the country.

According to an article by Forbes, these special technology zones will provide a legal and institutional framework for hi-tech industries in Pakistan.

3. **Pakistan Engineering Council (PEC):** PEC is a regulatory body that oversees the engineering profession in Pakistan. It is responsible for maintaining the standards of engineering education and professional conduct of engineers.
4. **Pakistan Software Export Board (PSEB):** PSEB is a government agency responsible for promoting and developing the software industry in Pakistan. It provides support to software companies by offering incentives and facilitating access to resources. According to Bloomberg, Pakistan is looking to double its IT industry in two years by setting up dedicated tech zones across the country, after missing out on tech booms that helped nations like India and the Philippines. Pakistan's industrial sector (in FY21) accounts for 28.11% of the GDP. Of this, manufacturing makes up 12.52%, mining constitutes 2.18%, construction makes up 2.05%, and electricity and gas 1.36%.
5. **Securities and Exchange Commission of Pakistan (SECP):** SECP is the regulatory authority that oversees the securities market in Pakistan. It regulates the initial public offerings (IPOs) of hi-tech companies and ensures compliance with regulations.
6. **Pakistan Telecommunication Authority (PTA):** PTA is a regulatory authority that oversees the telecommunication sector in Pakistan. It ensures compliance with regulations and promotes competition in the industry.
7. **National ICT R&D Fund:** The National ICT R&D Fund is a government organization that funds R&D projects in the ICT sector. It provides funding for the development of new technologies and innovative products. Additionally, Pakistan has more than 2,500 registered IT organizations in the country, with more than 20,000 computer science majors entering the market every year.
8. **Technology Parks:** The government of Pakistan has established several technology parks to provide infrastructure and support for innovative industries. The technology parks are designed to provide a conducive environment for research and development, as well as for the commercialization of new technologies. Pakistan has also developed an innovation management framework for the ICT sector, which identifies the factors affecting innovation and provides guidelines for enhancing innovation performance. The legal framework for the hi-tech industry in Pakistan includes government-sponsored initiatives that have allowed for the creation of special

technology zones. These zones aim to boost the IT economy of the country by incentivizing tech companies to open their operations within the country through tax-exempt programs.

In conclusion, Pakistan has a legal and institutional framework for the hi-tech industry that provides protection to inventors, innovators, and creators of original works. The government has established institutions and regulatory bodies to promote and regulate the industry. The National ICT R&D Fund provides funding for R&D projects in the ICT sector. However, there is room for improvement in the implementation of the legal and institutional framework to ensure a more conducive environment for the development of the hi-tech industry.

Comparative Analysis of the Role of the Hi-Tech Industry in Pakistan with the Best Practices Around the World

HI-TECH EMERGING INNOVATIVE INDUSTRIES AND WORLD BEST PRACTICES

Before making a comparative analysis between Pakistan and the rest of the world, we need to enumerate hi-tech and emerging innovative industries across the globe. Here are some emerging technologies around the world that could revolutionize agriculture, health, and the environment, according to experts convened by the World Economic Forum:

1. **Artificial Intelligence (AI) and Machine Learning:** AI and machine learning are becoming increasingly important in various industries, such as healthcare, finance, and transportation. Companies are investing heavily in AI to improve efficiency and productivity. According to a September 2018 report by the McKinsey Global Institute on the impact of AI on the world economy, artificial intelligence has the potential to incrementally add 16 percent, or around \$13 trillion, by 2030 to current global economic output. This is an annual average contribution to productivity growth of about 1.2 percent between now and 2030. Another report by PwC suggests that AI could contribute up to \$15.7 trillion to the global economy in 2030, more than the current output of China and India combined. Of this, \$6.6 trillion is likely to come from increased productivity, and \$9.1 trillion is likely to come from consumption-side effects.
2. **Renewable Energy:** As concerns about climate change continue to grow, the demand for renewable energy sources such as solar and wind power is increasing. This industry is expected to continue to grow rapidly in the coming years. According to a report by Allied Market Research, the global renewable energy market was valued at \$881.7 billion in 2020 and is projected to reach \$1,977.6 billion by 2030, growing at a CAGR of 8.4% from 2021 to 2030. Another report

by Business Wire suggests that the global renewable energy market had total revenues of \$692.8 billion in 2020, representing a compound annual growth rate (CAGR) of 8.9% between 2016 and 2020.

3. **Electric Vehicles (EVs):** The demand for electric vehicles is growing as consumers become more concerned about the environment and the cost of traditional gasoline-powered vehicles. Companies such as Tesla, Volkswagen, and General Motors are investing heavily in this industry. According to a report by Allied Market Research, the global electric vehicle market was valued at \$163.01 billion in 2020 and is projected to reach \$823.75 billion by 2030, registering a CAGR of 18.2% from 2021 to 2030. The near-term outlook for EV sales is bright. In the first quarter of 2021, global electric car sales rose by around 140% compared to the same period in 2020.
4. **Biotechnology:** Biotechnology is an emerging field that focuses on using living organisms and biological processes to develop new products and technologies. This industry has the potential to revolutionize healthcare, agriculture, and environmental sustainability. According to a report by Grand View Research, the global biotechnology market size was estimated at USD 1,023.92 billion in 2021 and is expected to grow at a compound annual growth rate (CAGR) of 13.9% from 2022 to 2030. The global biotechnology market was estimated at USD 859.94 billion in 2022 and is expected to be worth around USD 1,683.52 billion by 2030 with a noteworthy CAGR of 8.7% from 2023 to 2030.
5. **Blockchain Technology:** Blockchain technology is a distributed database that allows secure, transparent, and tamper-proof transactions. This technology has the potential to disrupt various industries, including finance, healthcare, and supply chain management. According to a report by Future Market Insights, blockchain technology accounted for around 5% share of the global digital transformation market in 2022. The blockchain technology market is predicted to surge at an exemplary CAGR of 44.3% through 2033, reaching US\$ 181.1 billion in valuation, up from just US\$ 4.6 billion in 2023.
6. **Cybersecurity:** With the rise of digital technology, cybersecurity has become an increasingly important concern. Companies are investing in cybersecurity to protect their sensitive information from cyber threats. According to a report by Allied Market Research, the global cybersecurity market size was valued at \$197.36 billion in 2020 and is projected to reach \$478.68 billion by 2030, growing at a CAGR of 9.5% from 2021 to 2030. The global cybersecurity market was valued at USD 150.37 billion in 2021, and it is expected to reach a value of USD 317.02 billion by 2027, registering a CAGR of 13.37% during the forecast period 2022-2027.

7. **Virtual Reality (VR) and Augmented Reality (AR):** VR and AR are emerging technologies that have the potential to revolutionize various industries such as gaming, entertainment, education, and healthcare. According to Statista, the revenue in the AR & VR market is projected to reach US\$31.12bn in 2023. Revenue is expected to show an annual growth rate (CAGR 2023-2027) of 13.72%, resulting in a projected market volume. The global extended reality (XR) market that includes augmented reality (AR), virtual reality (VR), and mixed reality (MR) reached 29.26 billion U.S. dollars in 2022.
8. **Internet of Things (IoT):** The IoT involves connecting everyday devices such as cars, appliances, and wearable technology to the internet. This allows for better data collection and analysis, leading to improved efficiency and productivity in various industries. According to Fortune Business Insights, the global internet of things (IoT) market size was valued at USD 384.70 billion in 2021 and is projected to grow from USD 478.36 billion in 2022 to USD 2,465.26 billion by 2029, at a CAGR of 26.4% during the forecast period. The total IoT market worldwide was worth around 182 billion U.S. dollars in 2020 and is forecast to rise to more than 621 billion U.S. dollars in 2030.
9. **Nanotechnology:** Nanotechnology involves the manipulation of matter at the atomic and molecular level and has applications in medicine, electronics, and other industries. According to Allied Market Research, the global nanotechnology market size was valued at USD 1.76 billion in 2020 and is projected to reach USD 33.63 billion by 2030, registering a CAGR of 36.4% from 2021 to 2030. The nanotechnology market in the U.S. was worth US\$16 billion in 2020. The country currently accounts for a 29.53% share of the global market.
10. **Robotics:** Robotics technology has a wide range of applications in manufacturing, healthcare, and other industries. According to Fortune Business Insights, the global industrial robots market size was valued at USD 15.60 billion in 2021 and is projected to grow to USD 35.68 billion by 2029, exhibiting a CAGR of 11.4% during the forecast period. The robotics market is anticipated to register a CAGR of 17.6% during the forecast period. We expect the global robotics market to climb from about USD 25 billion this year to between USD 160 billion and USD 260 billion by 2030, with market share for professional services robots hitting up to USD 170 billion and industrial and logistics robot sales topping off at about USD 80 billion.

POTENTIAL SECTORS FOR HI-TECH, INNOVATIVE, AND EMERGING INDUSTRIES IN PAKISTAN

Pakistan has a diverse economy with opportunities in a variety of sectors. Some potential sectors for high, innovative, and emerging industries in Pakistan are:

1. **Information Technology (IT):** Pakistan has a rapidly growing IT industry with a large pool of talented software developers and IT professionals. The government is also investing in IT infrastructure, making Pakistan an attractive destination for IT outsourcing and software development. Pakistan's IT sector is one of the fastest-growing sectors in the country. The country has a large pool of young, educated, and tech-savvy talent, which makes it an attractive destination for IT companies. Pakistani IT companies have begun developing software for use in different types of businesses and services. Locally made software packages are available for implementation in schools, hospitals, supermarkets, and other businesses at low cost. According to data released by the State Bank of Pakistan, remittances under IT and IT-enabled services surged to \$1.119 billion from July 2020 to January 2021 compared to \$812 million recorded previously. The IT minister has set forth an ambitious target of \$5 billion in IT exports for FY 2023 and \$15 billion in the next five years. Pakistan has already posted an export growth of 150% in IT exports during FY 2019 – FY 2022.
2. **Agriculture and Agribusiness:** Pakistan has a vast agricultural sector and is known for its production of rice, wheat, and cotton. With the right investments and modernization, the agriculture sector can become more productive, efficient, and innovative. Agribusiness and food processing are also potential areas for growth and innovation. Agriculture is the foundation of Pakistan's economy. It accounts for over a third of export earnings, and that sector is struggling. The annual agricultural growth rate averaged just 2.8 percent from 2010 to 2014, a significant drop from the growth rates experienced during the previous two decades. Pakistan's traditional, subsistence agriculture is becoming commercial, albeit slowly. Directly and indirectly, the sector is the main source of income for about 66 percent of the rural population. Agriculture contributes about 18.5% to GDP, provides livelihood to 64% of rural inhabitants, and employs 38.5% of the total national labor force.
3. **Renewable Energy:** Pakistan has enormous potential for renewable energy, including solar, wind, and hydropower. The government is actively encouraging investment in this sector to reduce the country's reliance on fossil fuels and to meet its growing energy needs. Around 10.57% of Pakistan's total installed power generation

capacity (in 2020) comes from renewable (wind, solar, and biogas). Most of Pakistan's renewable energy comes from hydroelectricity. As per the vision of the Prime Minister, there is an aim to "induct 20% of RE by the year 2025 and 30% of RE by the year 2030." Utilizing just 0.071 percent of Pakistan's area for solar photovoltaic (solar PV) power generation would meet Pakistan's current electricity demand. Wind is also an abundant resource.

4. **Healthcare:** Pakistan has a large population with significant healthcare needs. There is a growing demand for high-quality medical services and products, including pharmaceuticals, medical devices, and telemedicine. The healthcare sector in Pakistan is in need of innovation and investment. There is a growing demand for healthcare services, and there is a need to develop new technologies and solutions to address the country's health challenges. The Government of Pakistan (GOP) spent about \$785 million on healthcare in the fiscal year ending June 2021. The medical devices market in Pakistan is estimated at \$500 - \$600 million with an estimated growth rate of 15 percent CAGR over the next five years (2019-2023). The National Health Vision Pakistan 2016-2025 aims to provide universal health coverage and access to quality health services for all citizens of Pakistan.
5. **Textiles and Apparel:** Pakistan is a major producer and exporter of textiles and apparel, with a highly skilled workforce and a competitive cost structure. There is potential for innovation in textile manufacturing, such as the use of sustainable and eco-friendly materials. The textile and apparel sector of Pakistan is one of the most energetic, dynamic, and export-oriented sectors in the country. It encompasses a unique distinction of having intensive backward and forward linkages, which translates into an extended value chain starting from cotton ginning to a finished product marked by modern fashion. It contributes around 60% of total exports and provides a platform for large, medium, and small-scale manufacturing and employment. The textile and apparel sector holds a 60% share in total exports and contributes 8.5% to the gross domestic product (GDP). The industry provides direct employment for about 40% of the country's total industrial workforce.
6. **Construction and Real Estate:** Pakistan is experiencing rapid urbanization, with a growing demand for housing, commercial buildings, and infrastructure. There are opportunities for innovation in sustainable construction, affordable housing, and smart cities. The construction sector provides up to 380 billion PKR in GDP and has been declared an industry. The real estate market capitalization of Pakistan is valued at over \$1 trillion, which is more than three times that of Pakistan's GDP. According to the World Bank estimate, the size of a country's real estate assets constitutes between 60 and 70%

of the country's total wealth. If these estimates are applied to Pakistan, the estimated size of the real estate sector would be \$300 to \$400 billion.

7. **Biotechnology:** Pakistan has a rich biodiversity, which makes it an ideal location for biotech research and development. The biotech industry has the potential to create new drugs, improve agricultural productivity, and address health challenges in the country. Biotechnology has considerable potential for promoting the efficiency of crop improvement, food production, and poverty reduction in Pakistan. The use of modern biotechnology began in Pakistan in 1985, and there are currently 29 biotech centers/institutes in the country. Biotechnology offers a strong role in the environmental, medical, energy, and manufacturing industries. Additionally, biotechnologists are in high demand in Pakistan as well as abroad.
8. **E-commerce:** The e-commerce sector is rapidly growing in Pakistan as more people are using smartphones and the internet. The sector has the potential to transform the retail industry and create new jobs. According to a report by the Pakistan Institute of Development Economics (PIDE), the year 2023 could see Pakistan's e-commerce market reach a revenue of US\$6.4 billion, growing annually at 6.23 percent. By 2021, the market had hit US\$4.2 billion, ranking Pakistan 46th globally in this field. The News International reports that with a population of 208 million and several financial inclusion solutions, Pakistan is one of the largest unrealized markets of e-commerce in the world.
9. **Aerospace:** Pakistan has a long history of aerospace research and development, and there is a growing interest in the commercialization of space-related technologies. The government has established the Space and Upper Atmosphere Research Commission (SUPARCO) to promote space-related activities in the country. Pakistan Aeronautical Complex (PAC) is a major aerospace company in Pakistan that produces aircraft for both military and civilian use. The Pakistani Senate's Standing Committee has directed PAC to focus on five prime goals to boost the potential of Pakistan's aerospace industry. According to a report by Jattala, Pakistan's aerospace & defense market size is \$8.7 billion.
10. **Robotics:** Robotics is an emerging field in Pakistan, and there is a growing interest in the development of autonomous systems and drones. The country has the potential to become a hub for the development of robotics and automation technologies. According to an article by Daily Times, the potential of robots in businesses is not yet fully utilized in Pakistan.

Overall, Pakistan has significant opportunities in the emerging sectors mentioned above. However, to compete with the best global practices, it needs to invest heavily in R&D, improve its infrastructure, strengthen governance frameworks, and enhance collaboration with global players to foster innovation and technological advancement.

COMPARATIVE ANALYSIS OF THE ROLE OF THE HI-TECH INDUSTRY IN PAKISTAN WITH THE BEST PRACTICES AROUND THE WORLD

Pakistan's hi-tech industry is relatively nascent compared to other countries around the world. The industry has seen significant growth in recent years due to increased investment in infrastructure, education, and technology, but it still lags behind many other countries. In this comparative analysis, we will examine the role of Pakistan's hi-tech industry compared to best practices around the world.

1. **Investment in Research and Development (R&D):** Pakistan's government has invested in the hi-tech industry in recent years, with a particular focus on R&D. However, the investment in R&D is still relatively low compared to other countries around the world. According to the World Intellectual Property Organization (WIPO), Pakistan ranked 103rd in the world for R&D spending in 2019. In comparison, countries such as the United States, China, and Japan spend significantly more on R&D each year. According to an article in *The Express Tribune*, Pakistan's R&D expenditure as a percentage of GDP is less than that of India, Thailand, and Singapore. It averaged a meager 0.38% from 2005 to 2017 compared to 0.76% in India, 0.44% in Thailand, and 2.1% in Singapore.
2. **Access to Talent:** Access to talent is a critical factor in the success of a hi-tech industry. Pakistan has a large population, which provides a significant pool of potential talent. However, the quality of education and training available in Pakistan is not always up to international standards. Many tech companies in Pakistan have to invest heavily in training their employees to bring them up to speed with the latest technologies and practices. In contrast, countries like the United States, Canada, and Australia have world-class universities and training programs that produce a steady stream of highly skilled workers. According to *Rest of World*, Pakistan's startup boom has triggered a "war for talent." Flush with venture funding, tech companies are offering staggering salaries and perks, while recruiters struggle to retain candidates eager for the best deals.
3. **Infrastructure and Connectivity:** Infrastructure and connectivity are essential for the hi-tech industry to thrive. Pakistan has made significant progress in recent years in terms of improving its infrastructure, including the construction of new roads, bridges, and

airports. However, the country still faces significant challenges in terms of electricity shortages, slow internet speeds, and outdated technology. In contrast, countries like South Korea, Japan, and Singapore have world-class infrastructure and connectivity, which has helped them become leaders in the hi-tech industry. According to *Bloomberg*, Pakistan plans to boost spending on large infrastructure projects by as much as 40% to create jobs and foster productivity in an economy crippled by the coronavirus pandemic.

4. **Government Support and Policies:** Government support and policies play a significant role in the success of the hi-tech industry. Pakistan has taken steps in recent years to create a more business-friendly environment, including tax incentives and other support programs. However, there are still many bureaucratic hurdles that tech companies have to navigate. In contrast, countries like Singapore and South Korea have created favorable policies and incentives that have helped them become leaders in the hi-tech industry. Pakistan's tech industry is changing. Government-sponsored initiatives have allowed for the creation of special technology zones, which aim to boost the IT economy of the country. The government is offering a 10-year waiver on corporate tax and imports of any equipment or building material needed for these areas, which will give Pakistan's IT industry a "catapult push" that could double its size in two years.
5. **Entrepreneurship and Start-up Culture:** Entrepreneurship and start-up culture are essential for innovation and growth in the hi-tech industry. Pakistan has a growing start-up scene, but it still lags behind many other countries. In contrast, countries like the United States, Israel, and Singapore have vibrant start-up ecosystems that attract talent and investment from around the world. According to McKinsey, Pakistan is one of the youngest countries in the world, with 140 million people below the age of 30 and one of the fastest-growing economies in Asia. The country has a thriving start-up ecosystem, with an average of \$10 million a year in VC funding between 2016 and 2018. Shell Tameer is an entrepreneurship development program by Shell Pakistan that aims to encourage the development of entrepreneurial skills among the youth of Pakistan (ages 18-35).

In conclusion, Pakistan's hi-tech industry has made significant progress in recent years, but it still lags behind many other countries around the world. To catch up with the best practices in the world, Pakistan needs to focus on increasing its investment in R&D, improving the quality of education and training, improving its infrastructure and connectivity, creating more favorable government policies, and fostering a vibrant start-up culture.

SWOT ANALYSIS

SWOT analysis is a comprehensive tool used to identify the strengths, weaknesses, opportunities, and threats of a given industry or sector. It also includes an assessment of ethical, environmental, technological, and human factors that can impact the industry's growth and development. In this analysis, we will apply the SWOT-EETH framework to the hi-tech industry in Pakistan to identify areas for improvement and promote its growth.

Strengths:

- Low labor costs compared to other countries
- Growing pool of skilled workers
- Favorable government policies to promote investment in the tech industry
- Availability of tax incentives for tech companies
- Growing entrepreneurial culture and start-up ecosystem

Weaknesses:

- Poor infrastructure and connectivity
- Electricity shortages
- Limited access to funding and venture capital
- Limited support for R&D and innovation
- Inadequate regulatory framework for the hi-tech, innovative, and emerging industry
- Insufficient collaboration between academia and industry

Opportunities:

- Growing demand for technology products and services in Pakistan
- Increasing number of mobile and internet users
- Emerging markets for e-commerce and digital payments
- Potential for collaboration with international companies and investors
- Potential for greater government investment in infrastructure and R&D

Threats:

- Political instability and security concerns
- High competition from other countries with established hi-tech industries
- Limited availability of raw materials and resources due to financial constraints
- Environmental concerns related to electronic waste and energy consumption
- Ethical issues related to data privacy and cybersecurity

In conclusion, the SWOT analysis highlights the need for significant improvements in infrastructure, funding, and the regulatory framework to promote the growth of the hi-tech industry in Pakistan. The government

needs to invest in infrastructure, R&D, and human capital development. Additionally, laws and policies need to be developed to address ethical, environmental, technological, and human factors. Collaboration between academia and industry is also critical to promoting innovation and growth in the tech industry.

GAP ANALYSIS

GAP analysis is a useful tool for assessing the current state of a particular industry or sector, identifying areas where it falls short of expectations or benchmarks, and determining what steps need to be taken to bridge those gaps. In the case of the hi-tech, innovative, and emerging industry of Pakistan, we can carry out a GAP analysis as follows:

1. **Current state of the industry:** The hi-tech industry in Pakistan is still in its early stages and has a lot of potential for growth. However, it faces several challenges, including a lack of infrastructure, inadequate funding, and a shortage of skilled workers.
2. **Desired state of the industry:** The desired state of the hi-tech industry in Pakistan is to become a globally competitive sector that drives economic growth and innovation. This would involve creating an environment that fosters innovation, attracting investment, and nurturing a skilled workforce.
3. **Identifying the gaps:** Based on the current state of the industry and the desired state, we can identify several gaps that need to be addressed:
 - **Infrastructure:** The hi-tech industry in Pakistan requires significant investment in infrastructure, including high-speed internet connectivity, reliable power supply, and modern office spaces.
 - **Funding:** Access to funding is a critical issue for hi-tech startups in Pakistan. There is a need to develop a robust ecosystem of investors, venture capitalists, and angel investors who can provide the necessary funding for startups to grow and scale.
 - **Skilled workforce:** The availability of a skilled workforce is essential for the growth of the hi-tech industry. However, there is a significant skills gap in Pakistan, and there is a need to invest in education and training programs to develop the necessary skills in the workforce.
 - **Regulatory environment:** The regulatory environment in Pakistan can be challenging for hi-tech startups, with issues such as bureaucracy, corruption, and lack of transparency. There is a need to streamline the regulatory process and create a more supportive environment for startups.

4. **Developing a plan to bridge the gaps:** To bridge the gaps identified above, a comprehensive plan needs to be developed that addresses each of these issues. This could involve initiatives such as:
- **Investing in infrastructure:** The government and private sector need to invest in the necessary infrastructure to support the hi-tech industry, including high-speed internet connectivity, reliable power supply, and modern office spaces.
 - **Creating a robust funding ecosystem:** The government and private sector need to work together to create a robust funding ecosystem that includes venture capitalists, angel investors, and other sources of funding.
 - **Investing in education and training programs:** The government and private sector need to invest in education and training programs to develop the necessary skills in the workforce. This could involve initiatives such as creating specialized universities or training programs for the hi-tech industry.
 - **Streamlining the regulatory process:** The government needs to streamline the regulatory process to make it easier for startups to operate in Pakistan. This could involve simplifying the regulatory process, reducing bureaucracy, and increasing transparency.

In conclusion, the hi-tech, innovative, and emerging industry of Pakistan has a lot of potential for growth but faces several challenges. By carrying out a GAP analysis and identifying the gaps that need to be addressed, we can develop a comprehensive plan to bridge those gaps and create a more supportive environment for the hi-tech industry to thrive.

Conclusion

In conclusion, Pakistan's policies and regulations regarding adaptation to emerging innovative industries and hi-tech are crucial for its economic growth and development. With China's successful strategy of reverse engineering, Pakistan has an opportunity to learn from and implement similar strategies to become a leading player in these industries. However, this requires a comprehensive approach that involves collaboration between the government, private sector, and academia to create an ecosystem that fosters innovation, entrepreneurship, and technology transfer. Furthermore, Pakistan needs to prioritize investment in research and development, intellectual property protection, and regulatory reforms to attract foreign investment and promote domestic innovation. By doing so, Pakistan can leverage its strategic location, talented workforce, and abundant natural resources to become a hub of innovation and technological excellence in the region.

Recommendations

After conducting a SWOT analysis of Pakistan's hi-tech industry, it is clear that there are both strengths and weaknesses that need to be addressed. Furthermore, ethical, environmental, technological, and human resource factors also play a significant role in the industry's growth and success. Additionally, there is a need to learn from the Chinese strategy of reverse engineering to adapt and improve the policy and regulatory framework for the hi-tech industry in Pakistan. Here are some pragmatic recommendations to tackle the issues and challenges:

1. **Increase investment in research and development:** The government should focus on increasing investment in research and development to encourage innovation and the development of new technologies. This can be done through a combination of tax incentives, grants, and other support programs.
2. **Improve access to talent:** The government should focus on improving the quality of education and training available in the country, particularly in STEM fields. This can be done through partnerships with universities and training programs in other countries, as well as investment in local institutions.
3. **Improve infrastructure and connectivity:** The government should focus on improving the country's infrastructure and connectivity, particularly in terms of electricity supply, internet speed, and other critical infrastructure needs. This can be done through public-private partnerships and increased investment in infrastructure projects.
4. **Foster a vibrant start-up culture:** The government should focus on creating a more business-friendly environment, including tax incentives and other support programs that encourage entrepreneurship and innovation. Additionally, the government should work to reduce bureaucratic hurdles that make it difficult for start-ups to get off the ground.
5. **Develop a regulatory framework that encourages innovation:** The government should develop a regulatory framework that encourages innovation and experimentation while still protecting consumers and ensuring public safety. This can be done through partnerships with industry experts and other stakeholders.
6. **Intellectual Property Protection:** Intellectual property protection is crucial to prevent reverse engineering of products. Pakistan should develop and enforce strict laws to safeguard the intellectual property rights of companies investing in Pakistan's technology sector.
7. **Create an innovation ecosystem:** Developing an ecosystem that supports innovation is essential for emerging hi-tech industries. This

includes creating incubation centers, accelerators, and co-working spaces that help startups grow and access resources.

8. **Collaboration with China:** Collaboration with China could be beneficial for Pakistan's hi-tech industry. Pakistan can learn from China's experience in reverse engineering technology and innovation while working with Chinese companies to develop new technologies.
9. **Focus on niche industries:** To prevent direct competition with China, Pakistan could focus on developing niche industries that require specialized knowledge and cannot be easily replicated.
10. **Implement quality control measures:** Pakistan can implement strict quality control measures to ensure that its products are of a high standard and cannot be easily replicated by competitors.

In conclusion, Pakistan's hi-tech industry has significant potential for growth and success. However, there are several challenges and issues that need to be addressed, including investment in research and development, access to talent, infrastructure and connectivity, and regulatory frameworks that encourage innovation. By implementing the pragmatic

recommendations above, Pakistan can overcome these challenges and position itself as a leading player in the global hi-tech industry.

LOG FRAME MATRIX

The Logical Framework Approach (LFA) or Log Frame Matrix is a widely-used tool to plan and monitor development projects. It can also be used to devise a practical plan to address issues and problems related to Hi-Tech and Emerging Innovative Industries and Pakistan's Policies and Regulations Towards Adaptation in the Light of China's Strategies of Reverse Engineering. Here's a step-by-step guide on how to use the LFA:

Step 1: Identify the problem: The first step is to identify the problem or issue that needs to be addressed. In this case, the problem is that Pakistan is facing challenges in adapting to China's strategies of reverse engineering in the hi-tech and emerging innovative industries due to inadequate policies and regulations.

Step 2: Develop the problem tree: Once the problem is identified, develop a problem tree to identify the root causes of the problem. The problem tree will help identify the underlying causes of the problem and highlight areas that need attention. The problem tree for this issue may look like:

Problem: Pakistan faces challenges in adapting to China's strategies of reverse engineering in hi-tech and emerging innovative industries.

Causes:

- Inadequate policies and regulations
- Lack of skilled workforce
- Insufficient investment in research and development
- Limited access to technology
- Lack of collaboration between industry and academia

Step 3: Develop the objectives tree: Based on the problem tree, develop an objectives tree that outlines the desired outcomes of addressing the root causes of the problem. The objectives tree may look like:

Overall Objective: To improve Pakistan's adaptation to China's strategies of reverse engineering in hi-tech and emerging innovative industries

Intermediate Objectives:

- Improved policies and regulations for hi-tech
- Increased availability of skilled workforce
- Increased investment in R&D
- Improved access to technology
- Enhanced collaboration between industry and academia

Step 4: Develop the log frame matrix: The next step is to develop the log frame matrix, which outlines the project's goals, objectives, activities, and indicators. The log frame matrix may look like:

Goal: To improve Pakistan's adaptation to China's strategies of reverse engineering in hi-tech and emerging innovative industries

Objectives:

Outputs:

- 1.1: Policy and regulatory framework for hi-tech and emerging innovative industries developed
- 1.2: Stakeholder consultations conducted for policy development
- 2.1: Skilled workforce development programs implemented
- 2.2: Industry-academia collaboration programs established
- 3.1: Research and development investment increased
- 3.2: Technology transfer and adoption programs implemented

Indicators:

- 1.1.1: Number of policy and regulatory frameworks developed
- 1.2.1: Number of stakeholder consultations conducted
- 2.1.1: Number of skilled workers trained
- 2.2.1: Number of industry-academia collaboration programs established
- 3.1.1: Increase in research and development investment
- 3.2.1: Number of technology transfer and adoption programs implemented

Step 5: Implementation and monitoring: The final step is to implement the project activities and monitor progress toward achieving the desired

outcomes. The log frame matrix can be used to track progress and identify areas where adjustments are needed.

In summary, using the LFA and log frame matrix can help devise a practical plan to address the issues and problems related to Hi-Tech and Emerging Innovative Industries and Pakistan's Policies and Regulations Towards Adaptation in the Light of China's Strategies of Reverse Engineering. The plan focuses on improving policies and regulations, increasing investment in research and development, enhancing collaboration between industry and academia, and increasing the availability of skilled workforce and access to technology.

ACTION PLAN STEPS

To devise a practical action plan to find solutions to issues and problems of hi-tech, innovative emerging industries in Pakistan, we will have to follow these steps:

1. **Identify the issues and problems:** Start by identifying the issues and problems faced by the hi-tech, innovative emerging industries in Pakistan. This could be done through research, surveys, and interviews with industry experts and stakeholders.
2. **Prioritize the issues:** Once you have identified the issues, prioritize them based on their impact on the industry and the urgency of the solution.
3. **Formulate a task force:** Form a task force consisting of experts from relevant industries, academia, government, and other stakeholders to find practical and viable solutions.
4. **Set up a framework:** Set up a framework for the task force, defining its objectives, scope, roles, and responsibilities.
5. **Brainstorm and research:** The task force should conduct brainstorming sessions and research to come up with innovative solutions to the identified issues.
6. **Evaluate and select solutions:** Evaluate the proposed solutions based on their feasibility, cost-effectiveness, and impact. Select the most practical and viable solutions to the issues.
7. **Develop an action plan:** Develop an action plan to implement the selected solutions, including timelines, budgets, and responsible parties.
8. **Implementation:** Implement the action plan, keeping track of progress and making adjustments as necessary.
9. **Monitor and evaluate:** Monitor and evaluate the effectiveness of the solutions implemented and make necessary adjustments to improve their impact.
10. **Communicate the solutions:** Communicate the solutions and their impact to relevant stakeholders to raise awareness and encourage

further collaboration to promote hi-tech, innovative emerging industries in Pakistan.

PRACTICAL ACTION PLAN

Establishing a hi-tech, innovative emerging industry in Pakistan while considering China's reverse engineering strategies would require a multi-faceted approach. Here is a practical action plan that can be adopted:

1. **Identify potential industries:** Conduct a thorough analysis of the current market trends and identify potential industries that can benefit from hi-tech and innovative solutions, keeping in view Chinese reverse engineering strategies. We have already identified potential sectors for Pakistan, including biotechnology, artificial intelligence, renewable energy, etc. The Ministry of Industries and Production should start working on tapping the potential in these identified sectors. Pakistan Industrial Technical Assistance Centre (PITAC) is responsible for providing technical assistance and consultancy services to small and medium-sized industries in Pakistan, so this task should be assigned to PITAC. Identifying potential hi-tech industries in Pakistan requires a systematic approach that involves analyzing various factors. Some of the ways to identify potential hi-tech industries in Pakistan are:
 - **Market Analysis**
 - **Technology Landscape Analysis**
 - **Workforce Analysis**
 - **Government Priorities**
 - **Existing Industry Analysis**
 - **Global Trends**
2. **Create partnerships:** Establish strategic partnerships with universities, research institutions, and companies from around the world that have experience in the chosen industry. This will help in sharing knowledge, expertise, and technology transfer. Creating partnerships for the establishment of hi-tech and innovative industries in Pakistan can be beneficial for several reasons. It can help in leveraging the expertise of global players, technology transfer, and access to new markets. Here are some ways to create partnerships for the establishment of hi-tech and innovative industries in Pakistan:
 - **Attend Trade Shows and Conferences**
 - **Establish Business Incubators and Accelerators**
 - **Collaborate with Universities and Research Institutions**
 - **Engage with Diplomatic Missions**
 - **Establish Public-Private Partnerships (PPP)**
 - **Leverage Industry Associations**

3. **Focus on R&D:** Invest in research and development to create innovative solutions that have the potential for patenting. This will help protect intellectual property rights and prevent reverse engineering. Pakistan Institute of Development Economics (PIDE) is a research institute that provides policy advice to the government on economic development and industrial growth. To focus on research and development (R&D) for the establishment of hi-tech and innovative industries in Pakistan, the following steps can be taken:
 - **Create a Comprehensive R&D Strategy**
 - **Increase Funding for R&D**
 - **Establish R&D Clusters**
4. **Develop a strong legal framework:** Develop a strong legal framework that protects intellectual property rights and makes it difficult for reverse engineering. It should include patent protection, trademark protection, and copyrights. National Productivity Organization (NPO) aims to enhance productivity in the industrial sector by promoting the adoption of best practices and modern technologies, so this task could be assigned to them. Steps to develop a strong legal framework:
 - **Study Best Practices**
 - **Consult Industry Experts**
 - **Create Specialized Courts**
 - **Monitor and Update**
 - **Capacity Building**
5. **Invest in workforce development:** Invest in workforce development and provide training programs to create a skilled workforce that can help in the growth of the emerging industry. The training should focus on the latest technologies and innovative solutions. The National Vocational and Technical Training Commission (NAVTTTC) is the ideal body to assign this task.
6. **Provide government incentives:** The government should provide incentives for businesses that invest in the hi-tech and innovative emerging industry, such as tax breaks, subsidies, or other financial incentives.
7. **Build infrastructure:** Build the necessary infrastructure, such as research and development centers, incubators, and technology parks that support the emerging industry.
8. **Foster an innovation ecosystem:** Foster an innovation ecosystem that encourages collaboration, creativity, and innovation. This can be achieved by organizing innovation competitions, events, and workshops. The Trade Development Authority of Pakistan (TDAP) should be assigned this task.

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