

# **A COMPARATIVE STUDY ON THE CURRENT STATUS, TRENDS, AND CHALLENGES OF INVESTMENT IN SCIENCE AND TECHNOLOGY IN NEPAL**

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## **Abstract:**

This comprehensive study delves into the critical role of science and technology (S&T) investment in driving innovation and influencing a nation's GDP, examining both developed and least developed countries. The analysis encompasses key factors, such as the ratio of S&T investment to GDP, innovative indices, and the allocation of budget to GDP. It also includes a trend analysis of Nepal, extending predictions to 2030. Using data from 10 countries and various timeframes, the study explores transitions between income brackets and visually represents findings through curve fitting and histograms. Additionally, it compares innovation across nations using the Global Innovative Index (GII). Notably, Nepal's shift to a lower-middle-income nation is attributed to remittances and human capital, while Sri Lanka's decline is linked to debt levels and global economic factors. Nepal's specific challenges include budget constraints and issues within S&T subsectors. The study concludes by emphasizing the need for tailored problem-solving, as replicating foreign models may not effectively address unique challenges in economies like Nepal. Keywords: Research and Development (R&D), Global Innovative Index (GII), Gross Domestic Product (GDP), Science and Technology (S&T).

## **1. Background**

Investment in science and technology plays a crucial role in driving economic growth, innovation, and sustainable development in countries around the world. In the context of Nepal, a landlocked developing country with immense potential, understanding the state of investment in science and technology is of utmost importance. Nepal, situated in the heart of the Himalayas, has a rich cultural heritage and diverse natural resources. However, its scientific and technological capabilities have yet to reach their full potential. Adequate investment in science and technology is essential for addressing pressing societal challenges, improving the quality of life, and achieving sustainable development goals [1]. There is a fascinating example of countries that invested a proper amount in research and innovation, and as a result, it led to remarkable growth and transformation. Investment in research, science, and technology has fostered a vibrant ecosystem across different countries and also attracts international attention and investment. Investment in research and development addresses societal challenges and can tackle emerging issues such

as climate change, poverty, and public health issues [2]. In contrast, not only addressing societal challenges, evidence-based research, and insights can uplift technological advancements and other complex problems with practical solutions [3]. Through this study, we seek to address several key research questions. How does Nepal's investment in science and technology compare to other countries or regions with similar socio-economic characteristics? What are the drivers and challenges influencing investment in science and technology in Nepal? What are the existing policies and initiatives in place to promote investment, and what can be learned from successful case studies? By investigating these aspects, we aim to provide evidence-based recommendations for enhancing investment in science and technology in Nepal. The significance of this study lies in its potential to inform policymakers, stakeholders, and investors about the current state of science and technology investment in Nepal. By identifying strengths, weaknesses, opportunities, and threats, we can develop strategies to leverage resources, foster collaboration, and create an enabling environment for scientific and technological advancements. Moreover, this study contributes to the global discourse on investment in science and technology, highlighting the unique challenges and opportunities faced by a developing country like Nepal. In conclusion, the comparative approach allows us to gain valuable insights by examining the experiences of other countries or regions that have made significant strides in science and technology. By benchmarking Nepal against these entities, we can identify best practices, successful models, and lessons learned that can be adapted and implemented within Nepal's unique context. This knowledge exchange can facilitate the acceleration of scientific and technological advancements in Nepal and contribute to global scientific collaboration. This comparative study aims to analyze and evaluate the investment landscape in science and technology in Nepal while drawing insights from comparative countries or regions. By examining investment trends, drivers, challenges, and best practices, this study will provide valuable recommendations for policymakers and stakeholders to promote investment, innovation, and sustainable development in Nepal. Ultimately, this study seeks to contribute to Nepal's journey toward harnessing the full potential of science and technology for the betterment of its society and the global community.

## **2. Research and Development in Various Sectors**

The global landscape of science and technology investment is undergoing significant transformation, characterized by several noteworthy trends and shifts. Firstly, there has been a consistent uptick in the total investment allocated to science and technology worldwide [4]. Governments, private enterprises, and philanthropic organizations are recognizing the pivotal role of science and technology in driving economic prosperity and societal advancement, leading to increased funding for research and development, innovation, and technological progress [5-7]. One of the most remarkable shifts is the changing geographical focus of science and technology investment. Traditionally dominated by developed nations like the United States, Japan, and Western European countries, this arena is now witnessing the rise of emerging economies such as China, India, South Korea, and Brazil. These nations are significantly ramping up their investments in research and development, educational infrastructure, and innovation ecosystems, aiming to enhance their global competitiveness and foster economic growth [8]. Moreover, there is a growing emphasis on emerging technologies that hold the potential to disrupt industries and bring about transformative change. Areas such as artificial intelligence, machine learning, robotics, biotechnology, nanotechnology, clean energy,

and digital technologies are at the forefront of investment efforts. Governments and private investors alike recognize the profound impact these technologies can have and are channeling substantial resources into their research, development, and commercialization [9]. This focus on emerging technologies underscores the pursuit of innovation and competitiveness in the modern global economy. These trends collectively highlight the dynamic nature of science and technology investment on a global scale, with a shifting landscape that places a premium on innovation, collaboration, sustainability, and the harnessing of cutting-edge technologies to address complex challenges and shape the future.

### **3. Global Trend in the Investment of Science and Technology**

The global trend in the investment of science and technology is characterized by several notable patterns and shifts. The global landscape of science and technology investment is undergoing a profound evolution characterized by several pivotal trends. Firstly, there is a discernible and consistent increase in total investment in science and technology across the world. Governments, private sector entities, and philanthropic organizations are recognizing the paramount importance of research and development (R&D), innovation, and technological advancement in driving not only economic growth but also broader societal progress [11]. This heightened commitment reflects a growing understanding of the central role that science and technology play in shaping the trajectory of nations and their ability to thrive in an increasingly interconnected and competitive world. A notable shift in the geographical focus of science and technology investment is another salient trend. Historically, developed nations such as the United States, Japan, and Western European countries dominated this arena. However, there is now a significant realignment as emerging economies like China, India, South Korea, and Brazil are investing substantially in science and technology [12]. These nations are actively bolstering their R&D infrastructure, emphasizing education, and fostering innovation ecosystems bolster to their competitiveness and stimulate economic growth. This shift underscores the global redistribution of technological influence and innovation hubs. Moreover, there is a growing emphasis on emerging technologies that possess the potential to disrupt industries and usher in transformative change. These technologies span diverse fields, including artificial intelligence (AI), machine learning, robotics, biotechnology, nanotechnology, clean energy solutions, and digital innovations [13]. Governments and private investors are acknowledging the game-changing impact of these technologies and are directing substantial funding toward their research, development, and commercialization. This emphasis on emerging technologies reflects the dynamic nature of science and technology and its capacity to reshape industries, economies, and societies at large [14]. In conclusion, these trends collectively highlight the dynamic and evolving nature of science and technology investment on a global scale. As countries increasingly invest in R&D, innovation, and emerging technologies, they position themselves to remain competitive, address complex global challenges, and contribute to sustainable development goals. Collaboration and partnerships are essential in this endeavor, and the private sector's role in driving innovation and competitiveness is expanding. Additionally, the transformative potential of digital technologies is driving investment in areas like cybersecurity, IoT, and big data analytics. These trends collectively underscore the pivotal role of science and technology in shaping the future of nations and societies.

#### 4. Comparative Analysis

Irrespective of different cultural diversity, its geographical situation, advantages as well as disadvantages, here are the different 10 countries: Bhutan, Laos, Myanmar, Cambodia, Tajikistan, Haiti, Zimbabwe, Ethiopia, Nepal, and Sri Lanka selected for the analysis. The size of GDP, overall government investment, geo-political sensitivity, freedom from any trade or bottlenecks, and other factors are quite similar for these countries. Nonetheless, a few more similarities are in terms of geography, social structure, per capita income, political transition, and ethnic tension, and despite such analogies, there are few countries that have shifted themselves from poor countries to their best to change in a short period. Both are chosen to be compared here just to identify how change in one aspect, i.e., science and technology, shifts the paradigm by reforming and utilizing their resources at an optimum level, which in turn has contributed to a wider sphere. Further, we used a curve-fitting tool for the predicted value of the trend. Nepal's investment in science and technology has been gradually increasing. The government has shown an interest in promoting research and innovation, leading to the establishment of various science and technology institutions. However, challenges such as limited funding, inadequate infrastructure, and a brain drain of skilled professionals remain significant hurdles that need to be addressed to further propel the growth of Nepal's science and technology sector. The following analysis shows a comparison of investment in education and the Innovation Index between Nepal and selected countries:

##### **A Comparative Analysis of investment in education and overall GDP (%)**

Figure 1: Comparative Analysis of Investment in education of Overall GDP (in %)

Figure 1 shows a comparative analysis of investment in education in terms of overall GDP. According to the World Bank Analytical Classifications presented in World Bank Indicators (World Bank, 2012), lower income is considered to be below or less than 1085 dollars, whereas lower middle income is 1086 dollars to 4255 dollars, and upper middle income is 4256 dollars to 13205 dollars, whereas 13205 dollars and above are considered high income [15]. Bhutan used to be lower till 2005, but after 2006 it has been a lower middle-income country; Myanmar was lower till 2014 and then lifted to the upper middle thereafter; Cambodia shifted to the lower middle in 2015, whereas Nepal and Haiti in 2018 and 2020, respectively; Zimbabwe declined from the lower middle from 1991 to 2017 and 2018 onwards to the lower middle again. Concurrently, in the same epoch, Sri Lanka was in the lower middle since 1997, then hitched to the upper in 2018 and back to the lower middle again. The Tajikistan state has been oscillatory, upswing and slumping in the short term. whereas Ethiopia never shifted from lower income [5]. **a. Comparison of the Innovation Index (out of 100)** Figure 2: Comparison of Innovative Index (out of 100) Figure 2 represents the Global Innovation

Index (GII) and this indicator includes two sub-indices: The Innovation Input and Innovation Output. Each country's ranking has been given based on five pillars: Institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Institutional capabilities, quality, and regulation are the major contributing

factors for Innovation. To rank for political and operational stability Nepal has been ranked 115th whereas Srilanka is at 119th, Cambodia is 111th, Laos 130th, Tajiksthan is 118th, Bhutan is 63rd, and Myanmar is 137th out of 132 countries. This highlights more on institutions, political environment, regulatory environment, and business environment to develop the innovation faster.

**b. Government institutions in S&T and Proportion of Government contribution in R&D to GDP Figure 3: Total budget vs actual expenses in Government Institute in S and T**

The above table and figures show the actual budget allocated to government institutions for innovation, research, or areas that come under the scope of science and technology. It shows the real picture of the proportion of the science and technology sector that contributes to the overall GDP of the country. As shown in the table, along with the figure, the rate of total budget allocation to GDP is just around 0.63-0.77 percent. once increases from 0.63 to 0.77 in the first two years and proportionate decreases thereafter to meet 0.66 in 2022. This shows that the widespread infections and hospitalizations from the coronavirus pandemic cannot drastically change the perception of investing in science and technology. Out of the total budget allocated in FY 2078/79 for the Ministry of Education, Science, and Technology, according to the reports presented by the Auditors General, the discerned outcomes indicate 76 percent of the overall allocated budget has been invested in the projects of the National Forensic Science Laboratory and the BP Koirala Memorial Planetarium, observatory in Science, and their capital expenditure. 2 crore and 20 thousand had Institutions in S&T

profiling kits, and accessories. Out of the total budget allocated for the programs under the National Academy of Science and Technology (NAST), 59 percent of work had been completed, which in progress covered 95 percent of current expenses and 65 percent of capital expenditure. To conserve the mining sources and preserve and use them for sustainable growth, the National Mining Rules and Regulations 2074 have come into effect, with the aim of employing 50 thousand, of which 81 strategies have been mentioned. In the execution stage, steps like creating a database in a year of different qualities of mines and, with the help of ICT, monitoring mining activities, which in turn regulate the excavation of minings. Lastly, the plan of creating a special mining zone in 2 years and 3 years to create the geological map of mining has not been implemented in the full phase. In the renewable energy sector, the organization that promotes it here is the Alternative Energy Promotion Center (AEPC), which is a body of government under the Ministry of Energy, Water Resources, and Irrigation that operates mostly focusing on bio-gas, community bio-gas, an improved water mill, a solar water pump, a micro- hydro, an improved cooking stove, a solar mini-grid, etc. Its fund comprises the GoN fund, funding from donors with bilateral and multilateral loans, and subsidy funds. If we see the trend of the 1st year, AEPC had to return the amount of 1 Arba 97 crore to the Denmark and Norway governments. The tendency for the budget to be frozen is high. 18.55 percent of the overall plan had only been completed in the first year. In the

carbon trade, a 37 crore amount had been received as carbon emission reduction sales. Yet the proper guidelines must be made to initiate those funds properly. The success of programs was nearly identical in the second year. During the 3rd year, progress increased to 31.79 percent, and the carbon trade as part of the plan of clean development mechanism received a 23.5 crore amount as carbon trade, and guidelines were made to use it as an 80 percent subsidy and rest capacity upliftment. In the 4th year, Rs. 1 billion, 7 crore, and loans of 17 crore, of which 39 crore and 44 lakh had only been invested, In the installation of microhydro, 1880 were installed in year 4, and the carbon trade income balance was almost 60 crore. Last year, programs like solar mini-grid, solar pump, and ICS were taken into action. Rs. 36 crore, 51 lakhs invested in subsidy of the solar mini-grid; for solar pump programs in 44 districts, Rs. 27 crore, 2 lakhs; and in the Improved Cooking Stove (ICS), given a subsidy of 1 crore, 26 lakhs, which is ~Rs 4,000 for each ICS; the rest of the 20 percent subsidy had been given by the local government. The Department of Hydrology and Meteorology report by OAG shows that the budget allocation for the purchase and installation of radar in Udaypur, Chitram, and Ribdikote, Palpa, comprises a total budget of 39 crore, of which only 12 percent of work has been completed and radar has not yet been imported. Similarly, a Hydromet workstation was installed worth Rs. 12 crore. The National Health Research Council (NHRC) has done plenty of research and findings on non-communicable diseases and injuries, a National Mental Health Survey, a population-based cancer registry report, the effects of climate change on diarrheal disease, and convalescent plasma therapy to treat COVID-19 in Nepal. In their report presented by the scientific forest management technical testing committee, a few community forests taking samples tested whether the environmental and social aspects criteria met their standards or not, and they mostly kept records of every tree using GPS point records. Also, taking as a reference Mau Rukh, from where the radius of 5 meters has been kept and around 4 cardinal directions of that area, for the next 1-meter space, whether regeneration felling or not having regeneration feeling, they have the data for those for scientific forest management. An amount worth Rs. 1 crore and 44 lakhs has been invested in an internship program to learn, innovate, research, and uplift.

#### **Figure 4: Government contribution and its prediction in R&D in Nepal**

Figure 4 shows the distinction between the actual proportion of R&D expenditure to GDP with the predicted value. However, there is a steady increase in expenditure on R&D, whereas, the predicted value unless being hiatus, grows cautiously having a wider gap with the targeted value. In 2024, if to some degree the expenditure on R&D continues in the same way of decision-making will grow R&D expenditure as a proportion of GDP as 1 whereas the predicted value will be a bit lesser than 0.6. Analogously, if the same investing and real expenses paradigm continues till 2030, the real investment would be 1.5 percent, whereas the predicted value goes to meet 0.74 percent which still will encompass low coverage into science and technology investment and its results.

## **1. Summary of the Comparative Analysis**

In summary, the global landscape of science and technology investment is characterized by several notable trends, including increased total investment, a shift in geographical focus, a strong emphasis on emerging technologies, growing collaboration and partnerships, alignment with sustainable development goals, rising private sector investment, a focus on STEM education, and the pervasive influence of digital transformation. These trends collectively underscore the pivotal role that science and technology play in driving economic growth, addressing global challenges, and shaping the future of societies around the world. Nepal, too, is experiencing significant advancements and trends in the realm of science and technology. Some key trends in science and technology within Nepal include the remarkable growth of the information technology (IT) sector, the expansion of internet connectivity and mobile networks, a growing emphasis on harnessing renewable energy sources, strides in biotechnology and agricultural innovations, efforts to strengthen science education and research, the flourishing startup and innovation ecosystem, the adoption of digital payment systems, and the promotion of open data and civic tech solutions. These trends signify Nepal's commitment to economic growth, sustainable development, and digital transformation, as the country harnesses

technology, encourages innovation, and fosters a conducive environment for scientific and technological progress. Nepal is poised to leverage these trends to enhance its socio-economic landscape and contribute to global advancements in science and technology.

## **2. Conclusion and Recommendations**

In conclusion, the comparative study on the current status, trends, and challenges of investment in science and technology in Nepal reveals a positive trajectory of growth in recent years, driven by government efforts to promote research and innovation. However, persistent challenges such as limited funding, infrastructure deficiencies, and the brain drain of skilled professionals require ongoing attention and strategic interventions to foster sustainable development in Nepal's science and technology landscape. Emphasizing these areas is crucial to harnessing the nation's scientific potential and driving socio-economic progress. The issue is not merely the allocation of budget but the need for comprehensive planning, empirical data extrapolation, research application, diverse perspectives, and think tank involvement. Even with limited resources, improvements can be made in education, course design, learning habits, and efficient budget allocation. For forestry research and alternative energy programs, adherence to guidelines, involvement of local governments, and public-private partnerships are essential. Banks should play a role in monitoring subsidized loans, and technical education and vocational training programs need grassroots-level surveys to address real problems and drive meaningful economic growth, as simply replicating plans from other countries is insufficient for the development of science and technology in Nepal. Several strategies can be implemented to enhance investment in science and technology in Nepal. These strategies

aim to create an environment conducive to innovation, research, and technological development. Here are some recommendations:

- Allocate a higher proportion of the national budget to science and technology initiatives while implementing policies that encourage private sector investment and clear regulations to protect intellectual property rights.
- Improve STEM education at all levels and invest in modern research facilities, laboratories, and equipment, fostering collaboration between academia, research institutions, and industries.
- Establish technology incubators and accelerators, promote an entrepreneurial culture, and facilitate access to funding opportunities for startups and innovative ventures.
- Foster international collaborations and participate in global scientific networks, promoting technology transfer and knowledge exchange.
- Encourage public-private partnerships, create industry clusters, and provide support for startups and SMEs, driving innovation within specific sectors while enhancing science communication and public awareness to engage the wider community in the importance of science and technology. By implementing these strategies and others, Nepal can create a supportive ecosystem that attracts investment, nurtures scientific research, fosters innovation, and drives technological advancements. It will contribute to the country's economic growth, address societal challenges, and improve the quality of life for its citizens.

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