

The Role of Computers in India's Transformation

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Abstract

The role of computers in India's transformation has been pivotal, driving unprecedented growth and development across various sectors. This study explores how the introduction of computers in India, particularly after the liberalization of the economy in the early 1990s, has reshaped the nation's industrial, economic, and social landscapes. Key areas of impact include information technology (IT), education, governance, healthcare, and finance, where computers have enhanced efficiency, transparency, and accessibility. India's rise as a global IT hub, largely powered by computerization and digital innovations, has created millions of jobs, contributed significantly to GDP growth, and enabled India to compete on the global stage. Furthermore, the integration of computers in rural development, through initiatives like e-governance and digital education, has reduced the urban-rural divide and fostered inclusive growth. The study also highlights challenges such as the digital divide and cybersecurity concerns, while examining the future potential of computers and related technologies in shaping India's continued transformation.

Keywords: Computers, transformation, adoption and diffusion, software program development, digital innovation

INTRODUCTION

Computers have played a transformative role in shaping modern societies, and India is no exception. From the early days of mainframe computers to the current era of powerful personal devices and cloud computing, the technological evolution of computers has significantly influenced India's trajectory of development. While the global computer revolution gained momentum in the mid-20th century, India's journey towards computerization picked up pace in the 1980s, particularly with the advent of personal computers and the government's push for technology adoption [1].

The liberalization of the Indian economy in 1991 acted as a catalyst, opening the doors for rapid technological advancements and integration into the global digital economy. Over the past three decades, computers have permeated nearly every aspect of Indian life, from education and healthcare to governance, finance, and industrial production. As a result, India has emerged as a major player in the global IT landscape, contributing to innovation and service delivery worldwide.

Computers have significantly transformed the physical, social, cognitive, and economic landscape in which we live and work. Computers, in their web variants of the internet and World Wide Web, have

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become necessary, if not sufficient, causes of economic performance. If one sets at least a part of present-day development within reach of modular inputs, say as the human developed capacity or human capital, then computers are at the cutting edge of present-day offerings in this direction [2]. It is possible to draw up a list of concerns appropriate in this line of inquiry regarding investment in which computers may provide. It is now a cliché to declare that we are in the middle of an economic revolution characterized by a tight coupling of science and technology at the production end, and information

and communication technology at the distribution end. Technological change has penetrated and transformed every area of economic activity, including the domains of life away from the traditional economic stage. The case with information technology, however, is that its domain is entirely human or ethereal. This study initially outlines some of the more general areas of change driven by the rapid adoption and diffusion of computers in India. This is followed by an overview of the various regional data sources being researched for a more systematic inquiry.

This study examines the multifaceted role computers have played in India's transformation, focusing on key sectors such as the IT industry, education, e-governance, and rural development. By analyzing both the opportunities and challenges brought about by computerization, this study highlights how computers have not only fueled economic growth but also contributed to social inclusion, bridging gaps in access to knowledge and resources.

HISTORICAL CONTEXT

The first computer conference held in Asia took place in Bombay (now Mumbai) in 1953. At that conference, the argument was made that digital computers, useful for many tasks, were presently unavailable because of the lack of necessary monetary support. This concern was well founded. The Minister of Commerce and Industry said, "I am not at all satisfied with the response of Indian industrialists to this vital industry..." This history sets the context for the study of computers and automation in India today. Just how automatic and how computerized is modern India, really? In order to understand the significance of automation in India, one must proceed in both directions, backward through the divides of the political economy to the founding history of mechanical computation, and forward from industrial informatics to the contemporary conditions of consciousness and conscientiousness in India [3].

The efforts of early Indian computer scientists have laid a solid foundation for the work of the present. In 1958, an Electronic Computer Design Section was created at the Indian Statistical Institute in Calcutta, which later would be known as the Computer Center. At roughly the same time, more computer science education programs were developed at Calcutta University, Delhi University, the Indian Institutes of Technology, and at other universities and in new computer labs established by the Council of Scientific and Industrial Research and the Ministry of Defense. The first electronic computer in India, a Ferranti Mark I, was built at the Tata Institute of Fundamental Research in Bombay in 1954. It was created and constructed by a small team directed by Homi Jehangir Bhabha, the first chairman of the Indian Atomic Energy Commission [4]. This institute would remain the home of Ferranti Mark I, the most powerful and stable machine in the country, for nearly a decade before it was donated to the Indian Institute of Technology, Kanpur.

Early Development of Computers in India

Although electronic computers were late in arriving in India, the early development of computers came to shape larger questions about technology and its uses. Computers in India can begin from the late 1940s when the Department of Finance in the Government of India started discussions around the need for computers in the Indian context. They sought advice from pioneering computer practitioners and innovators [5]. The Goenka Commission in 1949 outlined the needs for computing machines for the country. This period was marked by the efforts of a few pioneering organizations such as Hindustan Aeronautics Ltd and the Tata Group. The work inspired by these individuals and start-ups demonstrated that hardware could be built in India, as could the ability to run numerical problems on computers. Some of the people who played a role in these efforts subsequently worked in various parts of the IT sector.

In the 1960s, a few limited experiments and projects were initiated mainly in research institutions and universities. The broad consensus is that since the late 1940s and the early 1950s, early efforts by Tata Institute of Fundamental Research and Defense Science Laboratories involved micro analysis of

social and anthropometric data, and the analysis of nutrition data at the Nutrition Committee Secretariat for the Government of India [6]. There were only a few commercial users of computers in the 1950s and 1960s. The Indian space program used computers in the development of rockets and satellites. Some large government laboratories also had a few computers at that time. A variety of factors inhibited speedy computing and data processing in the country during these early years. The first problem was a lack of resources and therefore a limited ability to expand rapidly. The second was a severe lack of PhDs and MScs in mathematics, statistics, and computer science. There was also a general shortage in programming manpower. The third was under-differentiation of areas of operation, with hardware and software operating in isolation. It was only the areas of research and development, for example in the Indian weather forecast system and models, which required computers with local software and hardware machines.

Government Initiatives

The adoption of this technology in a developing country like India has been nothing short of a miracle. But this transformation could not have been possible without the support and vision of the government. There have been a number of policies and programs for research and development in IT and its application for different sectors. The government invested heavily to help build a strong infrastructure in technology, networking, and training and implementation. The government recognized the importance of Information Technology in economic growth and thus established a number of institutions with a clear mandate to support education and research in computers. A lot of money was also spent on these institutions to introduce advanced research and training [7]. Finally, the government talked to the private sector to facilitate the adoption and exploitation of this technology. Information Technology has brought the world closer and has no history of artificial boundaries. In fact, computerization is such a fundamental process, whose dimensions no one has control over. It is too serious to be brushed off. The Indian government, in consultation with the private corporate sector, pursued a twin-tier computer policy of hardware and software. It launched various programs to accompany policy decisions. The seminars and meetings were held to identify the problems and prospects in computer education. The computer policy of India was reviewed. Subsequently, to give impetus to computer science education, the government established, as an interim mechanism, a Society for the Promotion of Information Technology for a period of 10 years in order to promote studies, research, and development in the field of Information Technology. The setting up of this society is primarily for research and training academic programs and software program development at the postgraduate level. The Government of India investment in the National Information System for Science and Technology was to the tune of 300 million [8]. The Department of Electronics through the Ministry of Education launched the National Task Force on Information Technology and Software Development for identifying measures for expediting IT-led growth trends in the country. This led to the National Policy on Software and its follow-ups.

IMPACT ON EDUCATION AND SKILLS DEVELOPMENT

Use of computers and other digital instruments, including the internet, can revolutionize teaching and learning in India. Over the years, computers have been integrated into the classroom to provide opportunities to extend and focus student learning. As a supplement to written textbooks, shaping or modifying a lesson to fit the needs of one particular class or group of students reduces the amount of time and energy required to plan lessons. Using computers as handouts for students presents the pupils with graphics, videos, and literature that will increase their learning comfort [9]. By using computers in schools, teachers can provide a greater variety of instructional methods. Because of technology, new teaching and learning methods are developed by accommodating digital resources such as courseware, tutorials, software, and others in the classroom.

Institutions, both public and private, are launching several ambitious pilot projects that will help in extending the reach of computers and computer education/IT literacy to our young students. The government has launched initiatives to provide free online training programs to improve digital literacy in rural India, and there is a proposal to create sub-centers in every state for imparting IT education.

Over the last decade, a large number of Indian educational institutions and organizations are using IT applications and various online learning resources to significantly expand the reach of their educational and/or training programs, especially in the field of IT and Computer Science in rural and non-urban areas to develop the trained and skilled manpower subset to meet the growing demands of the IT industry. Further, educational institutions have developed, improved, and designed various degree programs to meet global standards in education and research in IT and Computer Science. The college authorities provide continuous support and encouragement to develop such programs to cater to the needs of the economy. It is important to plan and design the courses according to national and international requirements. To achieve this, it is important that education imparts strong foundation courses with the purpose of developing application programmers or maintaining application systems using existing state-of-the-art technologies and also to introduce entry-level programming or computing courses to non-programming or non-computing majors. Computer/IT-literate individuals should also be able to work in any area of computing, such as newer areas of programming tools and software development in prime areas: artificial intelligence, engineering, cognitive computing, procedural and object-oriented programming skills; knowledge of scripting languages for experimental work and report generation; big data programming and neural network techniques for data science; programming using services in the cloud; training in hardware; developing websites and multimedia applications; creating desktop applications; and mobile apps [10]. This must be merged with the basic knowledge of computing to handle live projects and the ability to design and develop database application strategies. Knowledge of any operating systems to work with the elite domain architecture of computers is essential.

Why Indian Software Engineers are in High Demand?

Indian software engineers are in high demand globally due to a combination of technical expertise, cost-effectiveness, strong educational background, and adaptability. Here are some of the key reasons behind this demand.

Strong Technical Education and Talent Pool

India has a large, highly skilled workforce with a strong emphasis on STEM (Science, Technology, Engineering, and Mathematics) education. Many universities and institutes, such as the Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs), produce graduates with strong technical and engineering skills. With over a million engineers graduating each year, India offers a massive talent pool for software development.

Proficiency in English

English is widely spoken and used as the primary language in education and business in India. This makes Indian software engineers well-suited to work with international clients and companies, particularly in English-speaking countries like the United States, the United Kingdom, Canada, and Australia. Their language skills reduce communication barriers and allow for smooth collaboration in global teams.

Cost-Effectiveness

One of the primary reasons for the global demand for Indian software engineers is cost efficiency. Hiring Indian engineers is more affordable than their counterparts in countries like the US or Europe, allowing companies to save on development costs while still accessing top-tier talent. The availability of highly skilled professionals at competitive wages has made India a hub for outsourcing software development, IT services, and technical support.

Strong Work Ethic and Adaptability

Indian engineers are known for their strong work ethic, problem-solving abilities, and adaptability. They are accustomed to working long hours, dealing with complex projects, and meeting tight deadlines. This commitment to high performance makes them valuable assets to global companies. Additionally, Indian engineers are quick to learn new technologies and frameworks, staying relevant in a fast-changing tech landscape.

Experience with Global Clients and Outsourcing

India has been a leader in the global IT outsourcing industry for decades. Indian engineers and IT companies have extensive experience in working with clients from around the world. Many have developed expertise in handling complex, large-scale projects for global companies across industries such as finance, healthcare, manufacturing, and retail. This experience, combined with cultural adaptability, makes Indian software engineers highly effective in cross-border collaboration.

Emergence of Global Tech Hubs

Cities like Bengaluru, Hyderabad, and Pune have become global technology hubs, housing both multinational corporations (like Google, Microsoft, and IBM) and homegrown giants (like Infosys, TCS, and Wipro). The presence of these companies provides Indian software engineers with opportunities to work on cutting-edge technologies, gain global exposure, and develop expertise in areas like cloud computing, artificial intelligence, cybersecurity, and blockchain, increasing their appeal to global employers.

Growth in Emerging Technologies

Indian engineers are increasingly specializing in advanced and emerging technologies such as artificial intelligence (AI), machine learning (ML), data science, blockchain, and the Internet of Things (IoT). With global demand rising for experts in these fields, Indian software engineers who are skilled in these areas are in particularly high demand.

Cultural Fit and Flexibility

Indian professionals are known for their cultural adaptability and flexibility in adjusting to different work cultures. Their willingness to work in shifts that accommodate different time zones, particularly for clients in the US and Europe, makes them valuable for global businesses that require round-the-clock operations.

Supportive Government Policies

The Indian government has implemented several initiatives to promote the IT and software sector, such as “Digital India”, which aims to transform the country into a digitally empowered society. These policies encourage innovation, research, and development in technology, creating a thriving environment for software professionals.

Remote Work and Globalization

The rise of remote work, especially after the COVID-19 pandemic, has further boosted the demand for Indian software engineers. With companies worldwide increasingly comfortable with hiring remote teams, Indian software engineers are able to work for global companies without having to relocate, expanding opportunities for both talent and employers.

In summary, Indian software engineers are in high demand because they offer a combination of technical expertise, cost-efficiency, adaptability, and experience in working with global clients. Their strong educational background, fluency in English, and growing expertise in emerging technologies make them key contributors to the global technology industry.

ECONOMIC GROWTH AND DIGITAL INNOVATION

Computerization has become a principal driver of economic growth, and though digital innovation played a role earlier too, the scale and reach that computers and other digital have is unprecedented. A lot of contemporary businesses would not have been operative but for the widespread use of information and communication technology. For instance, sophisticated business practices such as outsourcing would have been far tougher and costlier without ICT. Indeed, India, with its recent emergence as a hub for IT-enabled services, as an e-commerce leader, and even as a home to a coterie of digital retail startups, shows how rapidly some business practices and consumption patterns are changing as a result of embracing computers.

One of the spinoffs of the growth of digital technology is the birth and blossoming of a new economic phenomenon: the digital economy. The digital economy comprises any services or products sold by a business model that is wholly on the web. By relying on data-driven segments, e-commerce software providers, manufacturers, and online publications, it is now more common than ever for businesses of all types to expand their footprint by employing technology. In India, a clutch of companies is doing extremely well by selling these or similar products and services. More than several thousand IT companies, including about 500 from the Fortune 500 club, have chosen to set up shop in India to carry out some of their back office operations. Indian-produced software services range from custom programming for foreign customers to packages for sale overseas. Some of the very few e-commerce startups that have well-established themselves are Sify.com, Indian Railway Catering and Tourism Corporation, BharatMatrimony.com, Shaadi.com, JobsAhead.com, naukri.com, rediff.com, IndiaTimes.com, MonsterIndia.com, Prajaavani, and IndiaTradeCentre.

CHALLENGES AND FUTURE PROSPECTS

India's excellent information technology and high-tech savviness across the world are making waves, as they have built an international reputation at their workplaces. Indeed, the advancement of computers has led to a relative insularity of awe in some sections of the world population, but mainly looked at computer forums; it has brought the world closer and has made everything almost available at a touch. Computers have, in fact, pushed aside the numerous back paper files to the plurality of office work. For want of a better expression or lack of a better alternative, one can say that computers have, in fact, entered Indian mainstream, in the sense that we do daily balance sheets with the help of computers, which are digitized, and that is to say that the computers provide us a real "binary code processing".

While computers have certainly been of help to men from various walks, there are challenges in fine-tuning and improving them for taking India into a higher orbit. Firstly, a sizeable section of the Indian population continues to have poor access, and technology should be used for greater community sharing. Secondly, India's infrastructure is inadequate to cope with the challenges of data transmission and retransmission. Consider the internet service provider's charge; it is exorbitant. Thirdly, there is the case of cybersecurity. Although there is an exclusive cell to deal with external cybersecurity threats, there are constant internal threats in the form of hackers and viruses or worms, with the capacity to put the whole system into disorder. Finally, and most importantly, there are not enough experts who can help design software or technical solutions in tune with the Indian economy. A vast majority of Indian IT professionals hone their skills just to work in multinational firms.

India's quest for technology development in the pre- and post-independent period of its history is analyzed. Its history, colonial past, culture, entrepreneurship climate, educational facilities and IT diffusion are all examined within this umbrella. The study uses historical data starting from the turn of the 20th century as it tries to identify the factors and then go beyond those factors to understand the strong historical and cultural roots that have affected the gradual evolution of the IT industry in India. The study shows that India's current position is a result of almost eight decades of sustained efforts by its political leaders and intelligentsia, aided by social, cultural, and historical factors that have driven public policy, to build a strong technology-infrastructure and to achieve self-reliance.

CONCLUSION

Computers have played a pivotal and transformative role in shaping India's progress. Over the last few decades, computers have not only revolutionized the Indian economy, especially through the rise of the IT industry, but also have brought significant improvements to education, healthcare, governance, and rural development. The advent of digital technologies has empowered millions, created jobs, and enhanced productivity across sectors, making India a global technology hub.

While the integration of computers has transformed urban centers and connected India to the global digital economy, it has also started to bridge the urban-rural divide. Government initiatives, such as e-

governance and digital education programs, have leveraged computer technology to foster inclusive development and bring essential services closer to underserved populations. However, challenges remain, including addressing the digital divide, improving digital literacy, and ensuring cybersecurity in a rapidly expanding digital infrastructure.

Looking ahead, the continued advancement of computing technologies, such as artificial intelligence, machine learning, and cloud computing, holds immense potential to drive further innovation and development in India. By addressing existing challenges and embracing these emerging technologies, India can continue its transformation into a digitally empowered society, capable of competing on the global stage while ensuring inclusive growth for all its citizens.

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