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India's Digital Revolution: Distinctive Features

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Abstract

The authors of the chapter analyze a number of characteristics that distinguish the digitization process in India from the digital transformation in other countries, and therefore, in their opinion, deserve special attention. One such important distinctive feature is the role of the state in this process, which has consistently laid the foundations for the digital transformation of the country, having created the most important digital platforms and keeping them freely available to citizens and businesses as public goods. The basis for these platforms has been India's biometric identity system of citizens called "Aadhaar". The other distinctive feature is the private-public partnership and the active participation of national private players in India's rapid digital revolution. In a matter of 5-7 years, digital solutions have occupied a significant place in the life of the Indian people. They now have overarching influence over most sectors of the economy, including primary and most conservative ones, like agriculture. Some of the most important consequences of India's digital makeover include increased financial inclusivity, better functioning social welfare system, as well as apparent surge in entrepreneurship, that has taken over the entire country. The paper pays attention both to the beneficial as well as to negative consequences of the digitization phenomenon, and examines the obstacles and limitations associated with the unprecedented growth of this sector in the context of India. Despite the strong political drive to bring India back to its cultural and historical routes, the country is simultaneously moving towards its very ambitious goal of becoming a new powerful technology player and a global innovation hub in the near future. Digital technology has occupied center stage in the vision of India's leadership and its citizens of what the country should be like in the XXI century. Successful digital transformation has given hopes about addressing many of the serious challenges that India faces today, such as the need to create jobs, improve quality of education, raise energy efficiency, promote sustainable development and combat climate change – by means of technology. These forward-looking aspects of India's digital revolution receive the attention of the authors too.

Keywords: *IT technology, digitization, Aadhaar, government policy, India*

I. Influence of Modern Information Technology

Technology has taken center stage in the vision of what India should be like in the XXI century. At the same time, one of the paradoxes of today's India is the desire of the country's leadership to achieve a technological breakthrough and at the same time – to return to the traditional foundations of the Indian civilization, which Indian leaders led by Narendra Modi see primarily in the canons of Hinduism and Vedic principles. India is making significant progress on the path of innovative development (Srivastava et al., 2022) and there is ample evidence that, despite some peculiar manifestations of the return of Indians to their roots, the country is simultaneously moving towards its very ambitious goal of becoming a powerful new technology player and global innovation hub in the near future. The hopes of leadership and citizens of the country about addressing many of the serious challenges that India faces today (from the need to create new jobs, to sustainable development and solving environmental problems) rest with innovations. Technologies, in particular, digital solutions, have already taken a significant place in the life of the country.

A possible explanation to this apparent contradiction between tradition and modernization may be due to the fact that the transformative aspects of technology are treated positively by the Indian people due to their holistic

perception of the world. They are not intimidated by the difficult changes associated with technological progress, because in the coordinate system of the Indian philosophy, change is the only constant in nature, and destruction and creation are the basic elements of nature. Being confident in the steadfastness of their deep cultural foundations, Indians see technological development not as a threat, but as a chance to solve the many challenges and problems facing their country today. One of the manifestations of India's significant achievements on the path of technological progress is its success in the field of digitization (Korovkin, Kulik, 2021). A number of features distinguish the process of digitization in India from digital transformation in other countries, including Europe, Russia, China and the US, and therefore it deserves special attention. One such important distinguishing characteristic is the role of the state in this process, which, through its consistent actions, has laid the foundations of the country's digital transformation by creating critical digital platforms in the shortest possible time and keeping them available to citizens and businesses as public goods.

II. The Importance of Aadhaar

Much has already been written about the biometric identification system of citizens, which has now covered over 1.3 billion people. The Indian biometric identification system is called 'Aadhaar', which means 'base', 'foundation' in Hindi and other North Indian languages. It is the world's largest biometric ID system. It was indeed conceived and implemented as a basic element of a more efficient and competent public administration and as the first fundamental identity proof issued by the Indian government. Efforts to create a large-scale nationwide database were first undertaken by the Indian Prime Minister Manmohan Singh in 2009. Prime Minister Narendra Modi gave new impetus to this initiative after coming to power in 2014.

Today, the important role of Aadhaar in transforming India is undeniable. The system has reached almost the entire population of the country, thanks to the hard work of numerous staff members of the Unique Identification Agency of India (UIDAI) and thought leaders such as Nandan Nilekani, the co-founder of IT and outsourcing major Infosys, who served as Chairman of the Agency for several years. At UIDAI, N. Nilekani managed to bring together the best of talent from the government and the private sector under one roof. Besides developing the Aadhaar architecture, it was a particular challenge to collect biometric data from citizens living in remote areas of the country. Local residents did not always understand why people with unusual devices –iris and fingerprint scanners, laptops and cameras– started appearing in their tiny villages, where officials had never been seen before. A lot of work was done in big cities, where registration officers literally knocked on the doors of all private houses and apartments. Registration and scanning centers were also located in schools and not far from the workplaces of large numbers of people. Maternity hospitals conducted a special program to register newborns immediately after birth. The laborious process of data collection for the Aadhaar system took several years.

Every resident of India is now assigned with a unique identification number, which is a randomly generated sequence of 12 digits to which biometric and other personal information of every citizen of the country is linked. The Aadhaar number has no specific function, and receiving it does not in itself mean automatic eligibility for any subsidies or services. Every resident of India can get an Aadhaar code, which allows a person to prove just one fact: "I am me". All the data of the Aadhaar system is stored on the servers of UIDAI's own data centers in Bangalore and Manesar. Initially, the Aadhaar system knows only four data elements about each holder besides biometric information: name, date of birth, address and gender. It only verifies that the biometric parameters match, without storing or transmitting anywhere the reason for the verification request or the details of the transaction. This system could potentially be used to collect and aggregate broader personal information such as credit histories, medical records, electronic signatures, etc. The regulation of access to this data is the subject of much debate in India. The Aadhaar system has a unique digital architecture that is characterized by low operational costs, high speed of introducing and processing of new data and ease of additions. All of this making it easy for virtually everyone in India to quickly and easily obtain their unique Aadhaar identification number.

III. Wide-ranging Opportunities

The original purpose of the new identification system was primarily to bring order to the distribution and delivery of social benefits to recipients, as this area in India had been inefficient for many years, resulting in large-scale waste of budgetary allocations and complicating the fight against poverty. Now, to access any government service, an Indian citizen needs his or her Aadhaar identification number. This digital code is a vital tool through which the Indian government has greatly improved the accessibility, transparency and accuracy of social payments, including

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allowances, pensions, scholarships, food and fertilizer subsidies. Most importantly, using the new identification system, hundreds of millions of Indians have been able to open their first ever bank accounts and start receiving subsidies through the banking system. Many of these people are women living in rural areas, the most vulnerable segment of the Indian society. Aadhaar is also a key component of the reform of household energy subsidies. This includes a shift from in-kind subsidies to bank transfers directly to households for the purchase of gas used for cooking. Various paper cards, databases and lists with repetitive or non-existent beneficiaries are now no longer necessary. This way India's digital welfare system was built up, providing the elementary safety-net for the country's poorest.

Linking a bank account, once verified through Aadhaar, to a cell phone number was another step forward that greatly enhanced the functionality of the identification system, making it the foundation for a cashless society in India. This triple combination received the name of JAM Trinity (consisting of Jandhan bank accounts, Aadhaar individual IDs and Mobile phone numbers). The Aadhaar system can be easily accessed by other systems and licensed service provides that also use open application programming interfaces (APIs), enabling fast verification of users. Hence Aadhaar is used for secure and inexpensive payments between businesses, individuals and government agencies, and numerous other services. This is a huge achievement, given the scale of the cash-based underground economy in India just several years ago, as well as various cultural complexities: for example, an illiterate person accustomed to identifying banknotes by color and size may find it particularly difficult to adapt to digital money.

The Aadhaar system proved its critical role during the COVID-19 crisis. At the peak of the pandemic, the Government of India effectively distributed direct financial assistance to the most vulnerable, totaling more than 430 million people, many of whom, such as migrant workers, were forced to change their location following the country's strict, prolonged and widespread quarantine. Overall, India met the pandemic quite prepared in terms of digital services, including digital finance, e-government and digitization of large and medium-sized businesses. The Aadhaar system is being used in India to organize vaccination – the mass campaign was conducted using the Co-WIN app. Through this application, developed in India and powered by Aadhaar, residents register for vaccination and very detailed statistics on the status of the campaign are being tracked.

Aadhaar has proven to be easy and efficient to build and operate, indispensable for governmental digital services and in demand by businesses. Aadhaar has become the foundation for IndiaStack – a set of basic nationwide digital services that rely on publicly available APIs, also created by the government as a public good. IndiaStack mechanisms allow government services and businesses to incorporate its elements into their work, quickly and inexpensively serving the demands of the population of a vast country. IndiaStack processes hundreds of millions of requests every day, both from government agencies and private companies. India's thinkers and experts behind IndiaStack we united at iSPIRT (Indian Software Product Industry Round Table), the industry nonprofit think-tank, where engineers work for free to design and promote digital public infrastructure. The most important components of IndiaStack are: the e-KYC (electronic customer identification system), which became operational in 2012, the UPI (fast payment system), which became operational in India in 2016, the electronic document issuance and storage system DigiLocker (2015) and the system of electronic signatures eSign (2015).

The India Stack element called KYC (Know Your Customer) also works on open source principles. It is used by large corporations as well as by numerous startups, medium and small businesses to comply with regulations. This system allows customers to prove their identity without any red tape, making it much easier and cheaper for a wide variety of businesses, not just in the financial technology and telecommunications industries, to expand their customer base. At the same time, significant decrease in switching costs helps promote competition.

IV. Government Policy Initiatives

India's UPI is a publicly available government service, which allows money to be sent swiftly between different financial service providers, including banks. Any financial organization, particularly any bank, can easily add UPI functionality to its mobile application. India was the first country in the world where with the touch of a button from a mobile app, in just 6 seconds, you could send money from your account in one bank to an account in another bank. This was a revolution in digital payments in India. Most importantly, the fast payment system has greatly expanded the convenience and available choices for businesses and consumers alike. The cost and time for customers to switch from one bank to another has been significantly reduced, which has stimulated competition in the financial market. This early and rapid shift to digital systems, aided with the painful demonetization of 2016 that marked the government's decisive crackdown on the shadow economy – have spurred not only a significant

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increase in financial inclusion in the Indian society, but also a boom in entrepreneurship in the FinTech segment in India. Companies such as PayTM, PhonePe and others have significantly expanded their business, becoming unicorn companies in just a few years.

A large part of the country's population skipped the stage of credit cards and ATMs when along with their first bank account they received in their hands an inexpensive smartphone as a convenient tool for financial transactions. UPI has surpassed the use of credit and debit cards in India, as it is used via mobile numbers or QR codes, with transactions ranging from a few rupees to 100,000 rupees per day per customer. Today India is the world leader in real-time digital payments. Thus, the campaign for financial inclusivity and transparency, promoted simultaneously on a number of fronts, has been one of the most successful and important aspects of India's digitization.

The evolution of the IndiaStack platform –from solving the identity problem with Aadhaar to the subsequent continuous addition of new interoperable modules for transactions, banking, bill payments and delivery of social benefits– demonstrates the growing value of this system for the large-scale democratization of access to digital services for all Indians. The Indian government continues to expand the functionality of IndiaStack, extending its reach to critical new areas such as health, education, energy, transportation, agriculture, and others. In a relatively short time, significant progress has also been made in India's e-government operations, with an e-government procurement platform, an extensive database of government documents and data, and a single-window system for accessing hundreds of government services, not only in a web-based version but also via a mobile app. The efforts of IndiaStack developers are now focused on launching and improving next groundbreaking large-scale platforms such as National Digital Health Mission (NDHM) and Unified Health Interface (UHI), Open Credit Enablement Network (OCEN), Unified Logistics Interface Platform (ULIP), AI4Bharat (building open-source language artificial intelligence for Indian languages), TelecomStack (India's own 4G and 5G telecom technology stack), Digital Ecosystem for Skilling and Livelihood (DESH), Open Network for Digital Commerce (ONDC), Account Aggregator network (a system for sharing financial data), to name a few. The way digital public infrastructure was built up in India reflects the country's overall approach to innovations. While Western countries mainly follow the "protect and profit" model of innovation, India's approach has traditionally been rather "share and grow". This method is closely connected with the fact that in India, informal innovation has always co-existed with the formal one, and an entire ecosystem of grassroots innovation, driven by the needs of India's communities and based on sharing of innovative solutions between people, has emerged over the years. Cost-efficiency and quality of India-born innovation is also reflected in the well-known examples and large-scale efforts such as India's space program and the way voting is organized all over India and the time of elections. Digital transformation in other countries was either commerce and advertising –driven or followed a very fragmented model (like in the US), was strictly regulated (as in Europe) or isolated and promoted by large enterprises (the case of China). In India, on the contrary, digital platforms were created as public utilities and financed by the government, they are open and tailored to the Indian context. With these efforts India has become the only country in the world operating an ecosystem of open and secure API's at this scale.

The affordability of Aadhaar, the functionality of IndiaStack and the independence and sovereignty of UPI are of great interest to other countries, many of which have expressed their intention to utilize India's experience. The success of the Aadhaar architecture led to the development, in partnership with iSPIRT and N. Nilekani, of the Modular Open Source Identity Platform (MOSIP). It is being promoted as "Aadhaar in a box" and made available free of charge by the International Institute of Information Technology, Bangalore (IIIT-B), with support from a number of prominent foundations including Omidyar Network, Bill Melinda Gates Foundation, Sir Ratan Tata Trust and others, as well as the World Bank. MOSIP allows governments to work with multiple application vendors, while maintaining an overall control of the system, it can also be customized and adapted to each country's needs, laws, levels of development of digital infrastructure and preferences.

The government's Digital India program, launched in 2015, focuses on developing broadband networks across the country, as well as improving digital literacy, training IT professionals, developing e-government and many other areas. If Aadhaar is the foundation, Digital India is the backbone of India's digital transformation. It is one of the most important flagship programs of the Indian government, overseen personally by N. Modi. It is closely linked to all other governmental initiatives aimed at transforming the Indian economy and modernizing the country to meet the demands and needs of the 4th industrial revolution, of which India plans to become an active participant. Digital India is influencing other programs such as Skill India (vocational training and skill development program), Startup India (entrepreneurship support program), Ayushman Bharat Yojana (government health insurance) and many others. It has also given a new impetus to "Make in India" initiative, which has now evolved into "Make in India, Make for India, Make for the World", reflecting India's desire not only to increase

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industrial production on its soil, but also to integrate the country more actively into the changing international supply chains, including in segments such as semiconductors, microprocessors and other high-tech products (Baru, 2022). The Indian government's arguably most ambitious program to date, AatmaNirbhar Bharat (Self-reliant India) –a set of stimulus measures (production-linked incentives) for a range of industries aimed at increasing India's self-sufficiency in virtually all categories of consumer goods and industrial products– also has a significant digital component. Even today, India ranks second after China in the production of smartphones and plans to become a leader in the production and export of various types of sophisticated high value-added goods.

This progress in digitization would not have been possible if Indians had not been provided with quality internet access in a short period of time. When the Prime Minister announced the launch of Digital India campaign, one could hardly hope that its key components would ever go beyond the big cities and touch the remote rural areas of the country, which often lack not just roads, electricity, telephones and computers, but even basic sanitation and clean water. Yet, in just a few years, this became possible, when large-scale government initiatives received well-coordinated support from the Indian businesses. Extensive and rapid change became a reality when India underwent a massive telecommunications revolution, making mobile internet available to virtually all Indians. The efficient synergy between the efforts of the Indian government and the private capital, although a subject for criticism from foreign players who could not withstand the unexpected competition, undoubtedly enabled the digitization of the entire country in the shortest possible time.

It would be fair to say that among the private companies that are changing the face of modern India through their innovative solutions, Reliance Industries plays a special role. Through the efforts of its owner, Mukesh Ambani, India's richest man, a Jio revolution has taken place across the country. It was Reliance Industries that quickly offered Indians low-cost high-speed Internet and affordable smartphones under the brand "Jio" (Hindi for "Live!"), realizing this complex telecom project on the footing of its successful petrochemical business. With the investments exceeding $33 bn, Jio Platforms has become the largest telecommunications company in the world. Jio Platforms, which entered the Indian market in 2016, quickly beat out the competition by offering free cell phones with free internet access and then charging a small traffic fee –thus, revolutionizing Indian telecommunications.

M. Ambani's goals for the rapid spread of affordable Internet were fully in line with the government's digitization drive, and his statements that Indian data should be stored in India appealed to the country's political leadership. IndiaStack too was built to make sure Indians regain control of their data, under the influence of concerns about possible digital colonization. The infrastructure and the entire digital ecosystem of Jio Platforms was built and operationalized in less than 2-3 years. The company rapidly rolled out a 4G network across all of India, including its most remote areas, while providing space for future technological advancements, including 5G and 6G capabilities. It provided its customers not only with low-cost smartphones but also with access to a wide-spread ecosystem of digital services –a variety of content and tools through its own mobile apps, which have become indispensable household brands in the lives of millions of Indians. Under Jio Platforms' own estimations, its potential contribution to India's GDP per capita growth was expected at 5.65%. To offset the high costs of setting up Jio, M. Ambani had initially planned to part with stakes in his petrochemicals business, freeing Reliance Industries from debt by 2021. However, a deal to sell 20% of his petrochemicals business to Saudi Aramco for $15 bn was called off in March 2020 after oil prices fell substantially amid the pandemic. This was followed by a string of deals to sell stakes in Jio Platforms to a number of international investors including Facebook, Google, KKR, Mubadala, Abu Dhabi Investment Authority, General Atlantic, Intel Capital, Qualcomm Ventures, Silver Lake and others, bringing the total level of foreign investment in Jio Platforms to 32.97% in a very short period. The trend of fast rate of growth in data consumption, in smartphone-users and internet-users base was significantly accelerated by the pandemic. The substitution of oil deals with deals in Jio Platforms was a clear evidence of the sound-bite notion that "data has become the new oil". Even "Jio" company logo apparently was intended by the company's founder to mirror the word "Oil". It also illustrated the outpacing growth in the demand for innovation in India and the big bets the international business was making on India going digital.

Another area where public-private partnerships are also playing a key role in India's development, and where the importance of concerted efforts between business and government will only grow, is improvement of accessibility and quality of education. Public universities, including the network of 23 institutes of technology across the country established by the Government of India starting from 1956, as well as other prestigious public schools, have been instrumental in creating the miracle of Indian IT and engineering. Today, India's digital economy, including its commercial segment, relies heavily on the traditionally strong community of Indian engineers and IT professionals. However, if the Indian government is to succeed in transforming India into a knowledge-based economy, it will need extensive private sector involvement in modernizing the Indian education as well, which must keep pace with

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the needs of economic development and inevitable changes in the labor market, influenced by digital transformation. The role of the private sector is increasing dramatically in both online and offline education in India, general and higher segment, and, very importantly, vocational training too.

V. Economic, Social, and Cultural Challenges

After an over 30 years gap, in July 2020, India unveiled a New Education Policy (NEP) that was further edited and detailed in 2023. NEP contains a broad set of measures that aim to address the problems that are slowing down the country's development and to make India's education system more efficient and fitting the 21st century requirements. The funding for India's education sector was set to rise to 6% of GDP. Greater emphasis is now placed on systemic investment in research and innovation, on early vocational education and training, entrepreneurial skills development and youth initiatives aimed at increasing employment and creating new jobs. The top 100 international universities are authorized to set up campuses in India. The new policy promotes a multidisciplinary approach to education to replace the rigid and inflexible division of disciplines that was prevailing earlier. The changes combine modernization of the sector with strengthening the country's traditions. Thus, while focusing on virtual learning, bridging the digital divide and promoting technological skills in Indian schools (students will be able to start learning coding as early as in the secondary school), the new policy simultaneously promotes the learning of Sanskrit, which will be offered to students at all levels of school and higher education. In support of the strong connection between tradition and modernity, even the Chairman of the Indian Space Research Organization (ISRO) recently spoke highly of the role of Sanskrit, one of the most ancient languages of the world, in India becoming knowledge society where maths, science, technology and philosophy flourished since Vedic times.

In a highly competitive environment, jobs have always been a valuable and scarce resource in India. Retraining and re-qualification of personnel is becoming an important aspect of the Indian society's adaptation to the profound transformation under the influence of technology. Increasing digital literacy is another crucial component of education policy that requires special attention. Today, people can get their hands on a smartphone with internet connectivity before they learn to read and write. This is a unique situation, the analog of which can be found only in African countries. While India's mainstream political forces have successfully taken advantage of the internet, in recent years it has become apparent that social media and messengers can also be a double-edged sword, becoming a source of fake news, disinformation and deep fake videos that can lead to dramatic consequences such as communal clashes and even lynchings. This is a very dangerous aspect of digitization for India and steps are being taken to neutralize these new threats. At the same time, economic development, including access to affordable technology along with rapid urbanization, is a strong equalizing factor. Although India remains a country with extreme income inequality, social stratification in the Indian society is gradually decreasing.

While there are certain areas where technology clashes with the realities of the Indian society and the interests of its citizens, in many cases technology and India's traditions are a perfect match. The phenomenal growth of data consumption in India in recent years, for example, is a testament to this complementarity. For the most part, this growth is attributed to social traffic. Indians like to keep in touch with their friends and family, and this social circle is usually very extensive. A taxi driver can be on the phone with his wife and kids all day long while he drives passengers. Another significant share of traffic is movies and music videos. Escape from reality to the dreamland of the Indian cinema has become much more accessible with the advent of inexpensive smartphones and cheap internet. Watching cricket matches has always been very popular too, and now it has become even easier and more convenient.

Smartphones have also helped create a new type of economy in India: the so-called "gig economy", in which millions of Indians now work as couriers, freight forwarders or cab drivers. On the one hand, this is helping reduce the unemployment; on the other hand, there has been a dramatic increase in traffic on the country's already busy streets. Another reason why Indian culture finds it difficult to adapt to the digital economy is that digitization eliminates middlemen in various spheres of life and business. While India is traditionally a culture and economy of mediation. It is not just about exploiting information imbalances, providing earnings and distributing profits to multiple people in the supply chain, it is also about communication and human contact. These are all very important nuances for a culture where business is closely tied to personal and family relationships.

Not only technology is changing India, but India itself is also contributing to the transformation of many technological solutions. One manifestation of this trend is the proliferation of apps and digital services in India's regional languages. While English is still the preferred language of communication across regions, technology companies have adapted to the country's regional specifics. "Act global, think local" is the mantra of global giants

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that made India their priority destination too, reflecting this localization in their user interfaces, voice and visual search that work in India's regional languages. Hence, the number of Internet users in India using local languages has surpassed the number of English-speaking users early on the way.

The quantum leap in which India transcended the stage of dedicated phone lines, computers and home internet by immediately getting the internet in smartphones has brought about profound changes in many areas. Amplified with strong engineering workforce, IT and managerial talents, rapid development of digital infrastructure in India has sparked the entrepreneurial surge of truly unprecedented scale. This has resulted in multi-billion-dollar valuations and investments, and, within just a few years, India has become the third largest startup ecosystem in the world after the United States and China. Despite the current global slowdown in funding, India retains this position. As per official estimations, the number of startups in India is approaching 100,000 (and growing across all regions), while the number of unicorn companies today stands at 108. The list of soon-to-be-unicorns is also impressive. The business of the vast majority of these firms is directly related to digital technology. Today in India, it is especially prestigious and fashionable to be a smart entrepreneur, innovator, inventor. While earlier Indian entrepreneurs were mostly copying existing Western business models, today they are developing original solutions dictated by India's needs and thus in demand in many other countries where customers are facing similar challenges. In the business culture where the customer is king and the market is utterly cost-conscious, consumers feel that with technology-enabled solutions they are getting good value for money. In the battle of unicorns, it is the customer who wins. The digital economy is expected to account for 18-23% of the country's GDP ($800bn-$ 1 tn) as early as 2025. Absolute majority of the new Indian companies have digital technology at the core of their businesses, but many of the new comers working in the areas of deep-tech, including artificial intelligence, machine learning, augmented reality and virtual reality, the internet of things, blockchain, cryptology, robotics, 3D printing, big data and analytics. Space sciences, technology and services, like satellites launches, also advanced significantly with the rise of digital economy in India, where demand for telecommunications and space data (including geo-positioning, agricultural, environmental, geospatial, meteorological and climate data) has grown multi-fold. To meet this demand, ISRO is now sharing its expertise and facilities with private partner-companies. Thanks to relaxed rules of private and foreign investment, entrepreneurship in space industry is growing too. Public digital infrastructure has also played an important role in building India's single national market. The country is no longer divided with interstate customs barriers, as it used to be just a decade ago. The introduction of all-India Goods and Services Tax (GST) has not just made trade easier, but also improved tax collection efficiency and increased corporate transparency. Digital tolling system on fast-expanding network on national highways contributed to making the market seamless. Despite the persistent regional differences, it is easier for companies to define and evaluate their addressable segments. Growth in per capita income in the country is helping businesses too by converting large population numbers into equivalent markets (Srivastava et al., 2022).

E-commerce was one of the first sectors of India's digital economy to experience a tremendous upswing, and this growth will continue in the future. At the same time, the proliferation of e-commerce has threatened the existence of micro and mini format outlets, the famous kiranas and street vendors. As of 2019, only a third of the country's small businesses had an online presence. They received a painful blow by severe lockdown during the pandemic. Both businesses and the government had to take urgent measures to rescue this segment that provides livelihood to tens of millions of people in India. Today, big digital businesses are making efforts to connect this segment to digital payment and commerce platforms, while the government is offering subsidized loans. Millions of SMEs are gradually coming online and a fast-growing number of small merchants across India are able to accept digital payments. This has allowed more small businesses to become part of the formal economy, making financial instruments more accessible to them.

Another sensitive sector for India, that accounts for 40% of the country's entire labor force, is agriculture. (Chand R., Singh J. 2022). Poor crop productivity, fragmented land holding, market information asymmetry, high dependence on monsoon and governmental subsidies is just a few of the list of problems aggravating the condition of the sector. On the other hand, BharatNet program, part of Digital India campaign, provided for 600,000 kms of optical fiber cable that brought fiber-based internet to 260,000 villages, making it the largest rural broadband connectivity program in the world, and the growth in use of smartphones in India's rural areas too has been faster than in India's cities. IndiaStack includes a platform called eNAM (National Agriculture Market), that was also launched in 2016. eNAM is the online trading platform for agricultural commodities in India, that helped remove market fragmentation, improve real-time price discovery and supply chains, and made marketing of agricultural goods much easier. The number of startups in agricultural technology sphere exceeds 2200, according to India's Department for Promotion of Industry and Internal Trade. The announcement, in 2023, about the establishment

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of "Agriculture Accelerator Fund", that aims to encourage agri start-ups founded by young entrepreneurs in rural areas, highlights the importance of this sector to India's decision makers. Despite emphasizing balance with nature at the heart of its philosophy and being one of the pioneers in international efforts towards protecting the environment (Sdasyuk, 2021), India is facing a tremendous challenge of raising millions of its people out poverty in a sustainable way and reversing the damage to the environment already done. Technology and solutions seeded in India's digital transformation are critical to achieving noticeable success on this way, be it about building smart grids in the power sector, creating effective water management systems or making India's cities truly smart. Technology, such as internet of things, has the potential to be a vital enabler to curb pollution, if applied in areas such as transportation, electricity grids, manufacturing, agriculture, land use, as well as emissions trading.

India plans a well-thought leapfrog in the development of electric vehicles industry. Moreover, there exists the potential for India to become the world leader in certain segments of electric vehicle industry, including research, development and manufacturing. Although this number has grown significantly in recent years, India still has a very low rate of car ownership and an absolute majority of motorized transport in the country consists of two-wheelers, another major group being economy four-wheel cars. India plans to concentrate on developing electric technologies in small vehicles segment, catering to this underserved market section on a global scale. Shared mobility that exploded in India in recent years due to digitization, is conducive of the development of the electric vehicles fleet, since it increases the vehicles utilization, critical to reducing the total cost of ownership. India's digital revolution has also created the prerequisites for better utilization of not just transport, but the entire infrastructure around it, too. Batteries constitute a large share of electric vehicle cost as well. India plans to develop the infrastructure of battery swapping and recharge stations, interconnected and enabled via mobile solutions, and encourage local manufacturing of batteries that would perform well in India's climate. This would also decrease the cost of these products and help them stay competitive globally in the spirit of "Make in India, Make for India, Make for the World".

Over 85% of India's oil consumption is currently covered with imports. Changing India's power mix, increasing the share of renewable energy in the country's production and consumption is one of the priority areas of the country's leadership and business. India is implementing the largest renewable energy expansion program in the world. Globally over the last decade, advances in technology have introduced the possibility of clean, low-carbon and inexpensive grids. Implementation of the ambitious program of electrifying India's road transport and making the air in India's cities breathable again would not be possible without creating digitally enabled smart grids in India's power sector, where most inefficiencies are concentrated in last-mile distribution segment. For many years India's primary focus in the energy sector was on improving access, but now smart solutions can help the country improve its distribution, transmission and, ultimately, the quality and reliability of the round-the-clock power supply to households and industries, including the newly emerging electric transport. The increasing use of renewable energy sources and distributed generation also requires next generation of grids that allow for the bidirectional flow of power (from the grid to customers or from customers to the grid, if customers have more power than they need from their own energy generating assets, or even hybrid or electric vehicles). The process of automating and optimizing the grid has four key digital components –self-healing grids, power-quality management, renewables integration, and demand-side management. All of these involve sophisticated hardware and information technology solutions as well as digitized power electronics –a segment that has the potential to become a valuable addition to the "Make in India, Make for India, Make for the World" portfolio of projects. Digitizing and automating the power grids on the scale of a country like India can be a daunting endeavor, but like in many other areas, India has the opportunity to leapfrog through many stages where other countries spent years. Artificial intelligence solutions play an important role in large-scale energy system performance modelling and forecasting. Having a significant advantage over other countries in the volumes of its data, as well as the talent pool, which India already started retraining towards these new technological requirements, the country is well poised to fulfil its ambition in this area too, provided smart data capturing and application are in place. While the government is developing Smart Cities program targeting 100 existing cities, it has also made endeavors to build urban settlements which have the amenities of a city but the spirit of a village, meaning that they should preserve the positive qualities of rural and suburban lifestyle, including its sustainability. Most of the problems, such as high crime rates, low living standards, congestion and water shortages, are presented mostly by unplanned urbanization. Despite well-recognized achievements in some of the areas related to making India's cities smart, such as, for instance, advances in development of e-government and improving power supply, India is just in the beginning of the way in applying technology to mitigating some of the complex challenges posed by its accelerated urbanization (Kulik, Nurgalieva et al., 2022). Fast pace of India's innovative development, particularly its rapid, profound

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and multifaceted digitization, give India additional instruments on the way towards sustainable development. India's pioneering contribution to finding new equitable, inclusive and just development models would have groundbreaking importance for the rest of the world and further raise India's prestige on the international arena. Paving the way for other high-growth developing countries in effective, technology-based sustainable development, would provide India with the new type of global leadership role that it seeks and deserves.

"Data for development" was the central theme of India's G20 presidency in 2022-2023. This was the opportunity for India to showcase its advancements in the digital sphere, where it has achieved so much in recent years, particularly in the field of digital strategy and digital governance. India's experience demonstrated that accessible digital architecture can stimulate socio-economic transformation. At the G20 fora India advocated global adoption of its IndiaStack experience, particularly the digital payments platform. At the time when data and financial sovereignty is becoming an increasingly important issue, this proposal coming from India was rather timely and received a lot of interest.

VI. Concluding Remarks

The changes associated with India's rapid digital transformation are often referred to as "revolutionary", "seismic", "tectonic". This is indeed so, while the process of digitization in India is following its distinctive path with its own unique profile. Coordinated efforts between government and business and close public-private partnership is one of its hallmarks, that has already enabled India to achieve remarkable results in the shortest possible time. India's example is inspiring other governments to develop digital platforms as a public good and to work closely with national businesses in making the robust digital infrastructure developed by the state serve the needs of the people. This new digital infrastructure, added with real highways, ports and airports, is fueling growth across the Indian economy, but particularly sectors such as banking and finance (15,6% sector growth in 2023), healthcare (22%), white goods (16%), FMCG (24%), consumer electronics (22%), automotive (13%), electric vehicles (60%), hospitality and tourism (10,6%), aviation (24%), and real estate (24,8%). Technology occupies a significant place in India's vision of its future role in the 21st century and reinforces among Indians the perception of their country as a center of global gravity. India aims to export its innovative digital solutions, setting ambitious goals to apply its expertise to help solve global problems and similar challenges that many other countries are facing today.

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