The Innovation Route to Development

Indo-US Perspective, 2020

CUTS International

#2005

The Innovation Route to Development

Indo-US Perspective, 2020

CUTS International

The Innovation Route to Development

Indo-US Perspective, 2020

Published by

CUTS International

D-217, Bhaskar Marg, Bani Park
Jaipur 302016, India
Tel: +91.141.2282821, Fax: +91.141.2282485
Email: cuts@cuts.org, Web site: www.cuts-international.org
CUTS offices also at Kolkata, Chittorgarh and New Delhi (India);
Lusaka (Zambia); Nairobi (Kenya); Accra (Ghana);
Hanoi (Vietnam); Geneva (Switzerland); and Washington DC (USA)

Edited by:
Udai S Mehta
Deputy Executive Director, CUTS International
and
Prashant Sharma
Senior Programme Officer, CUTS International

First published: March 2020

Citation: (2020), Mehta, Udai S and Prashant Sharma (Eds.), 'The Innovation Route to Development: *Indo-US Perspective, 2020*', CUTS International, Jaipur

ISBN 978-81-8257-282-9

Printed in India by MS Printer, Jaipur

#2005

Contents

Abbreviations

ABES	:	Advanced Battery Energy Storage
ACES	:	Advancing Commonwealth Energy Storage
ADB	:	Asian Development Bank
AI	:	Artificial Intelligence
AMP	:	Advanced Manufacturing Partnership
APMC	:	Agricultural Produce Market Committee
BFSI	:	Banking and Financial Services Industry
BHIM	:	Bharat Interface foe Money
BMW	:	Bavarian Motor Works
CAES	:	Compressed Air Energy Storage
CII	:	Confederation of Indian Industry
CPUC	:	California Public Utilities Commission
CSIS	:	Center for Strategic and International Studies
CSR	:	Corporate Social Responsibility
CVD	:	Countervailing Duty
DBT	:	Direct Benefit Transfer
DDD	:	Discovery Driven Disruption
DPU	:	Department of Public Utility
BTM	:	Behind The Metre
DRDO	:	Defence Research and Development Organisation
DTTI	:	Defence Technology and Trade Initiative
EV	:	Electric Vehicles
FDI	:	Foreign Direct Investment
FERC	:	Federal Energy Regulatory Commission
FES	:	Flywheel Energy Storage
FOGSI	:	Federation of Obstetric and Gynaecological Societies of India
GCC	:	Gulf Cooperation Council
GDP	:	Gross Domestic Product
GHG	:	Greenhouse Gas
GVCs	:	Global Value Chains
IFC	:	International Finance Corporation
ILO	:	International Labour Organisation
IoT	:	Internet of Things
IPRs	:	Intellectual Property Rights

ISTAR	:	Intelligence, Surveillance, Target Acquisition, and Reconnaissance
ITC	:	Investment Tax Credit
IUSSTF	:	India-US Science & Technology Forum
JCERDC	:	Joint Clean Energy Research and Development Centre
MeitY	:	Ministry of Electronics and Information Technology
MNRE	:	Ministry of New and Renewable Energy
N:P:K	:	Nitrogen, Phosphorus and Potassium
NDAP	:	National Data and Analytics Platform
NESM	:	National Energy Storage Mission
NIIF	:	National Investment and Infrastructure Fund
NWSHP	:	National Wind-Solar Hybrid Policy
OEMs	:	Original Equipment Manufacturers
PACE	:	Partnership to Advance Clean Energy
PCBs	:	Printed Circuit Boards
PFs	:	Pension Funds
PHS	:	Pumped Hydroelectric Storage
PHS	:	Pumped Hydroelectric Storage
PMFBY	:	Prime Minister's Fasal Bima Yojna
PMP	:	Phased Manufacturing Programme
PMS	:	Portfolio Management Services
PPPs	:	Public Private Partnerships
R&D	:	Research and Development
RoA	:	Return on Assets
RoI	:	Return on Investment
SDGs	:	Sustainable Development Goals
SECI	:	Solar Energy Corporation of India
SERIIUS	:	Solar Energy Research Institute for India and the US
SHC	:	Soil Health Card
STA	:	Strategic Trade Authorisation
TA	:	Technical Assistance
TDS	:	Tax Deduction at Source
UI-ASSIST	:	US-India Collaborative for Smart Distribution System with Storage
USAID	:	United States Agency for International Development
USFDA	:	US Food and Drug Administration
USISTEF	:	India-US Science & Technology Endowment Fund
VIN	:	Vehicle Identification Number

Editors Note

Udai S Mehta
Deputy Executive Director
CUTS International

Prashant Sharma
Senior Programme Officer
CUTS International

The notion of Innovation is making strides in all spheres of economic and development activities in India. Given the size of its population of 1.37 billion which is slated to surpass China's 1.43 billion by 2027, only to become the world's largest, it deems to be essential. The mainstream thinking is to generate jobs, improve skills and livelihoods as well as address development challenges confronted by the country.

Innovation is an apt response to address these challenges. With initiatives, such as Startup India, Skill India, Tinkering Labs at schools other than establishing New, Emerging and Strategic Technologies (NEST) division at Ministry of External Affairs, Government of India among others, the scope of expanding innovation and entrepreneurship in India looks promising. However, it is going to be a daunting task to even mobilise the vital support, let alone helping entrepreneurs realise their full potential unless the Whole-of-Government approach and efforts are backed by vibrant innovation ecosystems encompassing silos.

In this quest, it is required for India to not only develop wide arrays of such ecosystems but also integrate them globally to ensure greater flows of capital, knowledge, talent, and technology. In doing both, India can gain a lot from the US. The US has been an apostle of innovation and entrepreneurship for decades. Attributing the unparalleled might of the country to that spirit will not be an exaggeration. Not only did the US attract the best of the talents but ensured an enabling environment which in return helped the country remain on top of the innovation ladder. As a result, the US continues to be a progressive land driven by ideas, skills and collective efforts.

Silicon Valley in the country is touted to be the greatest ecosystem for innovation and entrepreneurship. It enjoys being the global hub of emerging and disruptive technologies. Also, the US has the highest numbers of startup unicorns in the world, a startup valuing more the US$1bn, among many other such distinctions. Around four million Indian Americans have contributed remarkably (and continue to do so) for America to remain ahead of the curve. This is a strong foundation available for the two countries to boost comparative linkages and develop innovation ecosystems in India. Not only will that complement in scale but also aligns well with the newly construed level of partnership, i.e. Comprehensive Global Strategic Partnership between the two countries.

At the two Indo-US innovation roundtables organised by CUTS (and in partnership with the leading Indo-US Business Associations)[1] in Washington DC and New Delhi in October and December 2019 respectively, innovation was recognised to be a catalytic

1 Report of the Roundtables on Fostering Indo-US Innovation Cooperation for Mutual Prosperity, available at: http://cuts-wdc.org/pdf/event-report-roundtable-on-fostering-indo-us-innovation-cooperation-for-mutual-prosperity.pdf

factor for taking bilateral relations to even higher levels. The participants in those two meetings urged that mutual concerns involving Intellectual Property Rights (IPRs) should be settled, without sacrificing individual development interests. A recent memorandum of understanding on IPR between the two countries signifies the efforts made in that direction.

As some IPRs may be perceived as a public good while others may not, the Indian and US authorities need to find several common grounds. An approach such as this is needed to enable the two way public and private sector partnerships to scale across India's economic and development landscape.

Above all, to develop innovation ecosystems in India, enabling narratives and deliverables (in terms of policies, incentives, capital, infrastructure, skills, technology, etc.) continues to be the need of the hour. Not to say that India is not doing enough but this can further be emboldened by strengthening cross-fertilisation of knowledge and learning between the US and India. Not only will that sustain the Government of India's efforts to boost the Indian economy but also provide the country's youth access to contemporary skills and technology.

This policy volume in this context draws a collective response by eminent experts and young scholars who provide some 'food for thought' for boosting innovation complementarities between the two countries. As a whole, it covers philosophical, sectoral and technological underpinnings and is comprised of fresh and adapted contributions from people from all walks of life. It includes reflections from well-known stalwarts, such as Shashi Tharoor, Arun Maira, Robert D Atkinson and Pradeep S Mehta along with many other experts and young scholars invested in driving the change. Moreover, the volume dovetails in-depth perspectives about fostering Indo-US innovation cooperation in agriculture, energy, education, defence, healthcare, infrastructure, investment, digital and 4IR technologies, manufacturing, etc.

Other than marking our sincere thanks and appreciation for these valuable contributions, we would like to also acknowledge the large number of submissions that we received in response to the call for papers in mid-2019. Regrettably, we could not accommodate all but convey our sincere gratitude for efforts put by everyone. Furthermore, we are overwhelmed by the invincible confidence and zealous trust of final contributors in CUTS as we tried to give the volume a holistic flavour over the past few months.

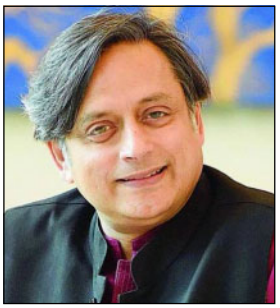
Last but not the least; this volume would not have been a reality without the constant guidance provided by Pradeep S Mehta, Secretary General, CUTS International. Our heartfelt thanks to him for showing us the way and keeping us motivated during the conceptualisation and implementation phases. We convey our gratitude to Bipul Chatterjee, Executive Director, CUTS International for all his inputs and critical support in helping us make this happen.

Furthermore, we greatly appreciate the support provided by Madhuri Vasnani and our former colleague Nimra Khan; other than colleagues who were, on many occasions, part of various reviews of submissions and discussions, mainly Amol Kulkarni, Shagufta Gupta, and Abhishek Kumar. We are also thankful for the diligent support provided by Mukesh Tyagi and Rajkumar Trivedi as well as Gyan Chand Jain and Sudharshan Jain, respectively from our publications and accounts & finance teams.

Let us conclude by acknowledging the support provided by Rajasthan State Industrial Development and Investment Corporation (RIICO) Limited in the form of their advertisement inside the back cover of this volume. We encourage and look forward to your readership, feedback, and support in wider circulation while assuring that CUTS will continue to take this treasure to relevant Indian and the US authorities.

POPULAR REFLECTIONS ON INNOVATION

Innovation in India



Shashi Tharoor
Member of Parliament (India), Lok Sabha

Startups have permeated our landscape, where Indians have disrupted mainstream ways of thinking, and embraced innovation with enthusiasm and spirit, finding new ways to answer old questions.

As a policymaker and someone who is captivated by the subject of innovation it is clear that with its capacity of overcoming and efficiently challenging our problems through critical and out-of-the-box thinking, innovation is poised firmly to become a significant driver of change in the 21st century. This is particularly true in India, where I believe that innovation holds the potential to transform the social trajectory of our 1.3 billion-strong population. India's example, as an increasingly innovation-driven economy that looks towards both innovation and entrepreneurship as the path to the future, where answers are being found through fresh ideas and fresh thinking, is one for the world to take note of.

The evolving technological space in the era of big datasets, blockchain and artificial intelligence, as well as burgeoning demand for new products and services within the domestic market, has been driven by factors, such as the availability of both domestic and international funding and consolidation activities by several firms. Startups have permeated our landscape, where Indians have disrupted mainstream ways of thinking and embraced innovation with enthusiasm and spirit, finding new ways to answer old questions.

When one studies the etymology of innovation, one finds its interestingly turbulent history. Innovation was once a derogatory term, not a complimentary one. Its redemption came with the influential 20th-century economist Joseph Schumpeter, who saw it as the greater end-product of any successful invention and as the precursor to development, locating entrepreneurship as the pathway between the two. The phraseology of disruption is now following the same roadmap.

However, the key terms here, innovation and disruption, have a long history in the development of India. In the land of Ayurveda, the country that invented the zero, making the decimal system possible; the land of the first recorded instance of rhinoplasty surgery over 2000 years ago; and the source of considerable innovation in fields ranging from astronomy to metallurgy the tradition of innovation is not a new one. But that is ancient history. One could argue that the

contemporary interest in innovation in the Indian context stems from the remarkable and proven record of Indians in globally recognised innovation hubs such as Silicon Valley, which, towards the end of the 20th century, saw the proliferation of several startups helmed by Indians.

In an interesting statistic I read recently, 13.4 percent of startups that originated in the Valley in the 1980s, 1990s and early 2000s were founded by Indians, many of which have gone on to become household names across the world. It is said that 40 percent of all Silicon Valley companies have Indians among their founders or in their leadership. Together with our historic aptitude for adaptability and entrepreneurial strengths, Indians succeeded in the US, and in a 'reverse brain drain', their spirit transferred itself to India. Today, the Indian city of Bengaluru is recognised as the 'Silicon Valley of India' and, if the city is more of a 'Silicon Plateau', I also know of a place near Mumbai that is jokingly called 'Powai Valley,' for the increasing number of startups that are located there.

> "We need to cultivate an ecosystem of innovation, as the right mind-set is often half the battle won in finding the right solution"

From OYO to Ola, Indian startups are taking on strong competition on the global landscape. Many of these have now joined the prestigious ranks of 'global unicorns,' — the nomenclature for privately held startups valued at over US$1bn, a term coined by Aileen Lee because of their rarity, or rather the mythicism of their possibility. But India's unicorns, unlike the ones of legend, seem likely to proliferate rather than become extinct.

We have invented our club for small businesses and young, but ambitious, ventures that we call 'nano unicorns.' This pilot project launched in the Indian state of Odisha promotes skill development and business capacities for individuals who display distinct entrepreneurial traits, whether it be the owner of a manufacturing unit or a roadside Indian street-food vendor. At the same time, we can boast of a 50 percent increase in start-ups concerned with advanced technology, especially the Internet of Things (IoT) and data analytics, setting the pace globally in tandem with the amplification of entrepreneurial diversity in India. How there is now a proliferation of startups within the country, a country that has emerged as the world's third-largest startup ecosystem (not less than 11,000 by 2020 from the reported 4700 startups in 2016), tells a much larger story.

India is the youngest major economy in the world. At a time when many of our potential competitors — China, Japan, South Korea — are facing a serious demographic squeeze, and of course, the rest of the world is aging (in Europe the average age is going to be 46 in 2020, in Japan it is going to be 47, in even youthful immigrant- fuelled America, it is going to be 40), the average age in India will be 29. So, we have this huge young population: almost 50 percent under 25, and approximately 65 percent under 35. A young country where fresh graduates will be joining a dynamic, competitive, productive, youthful workforce, which could be an engine of the world, primed to take over that role from China.

The International Labour Organisation (ILO) has predicted that by 2020, we will have, in India, 116 million workers in the job-starting age group of 20 to 24, whereas China will only have 94 million. These numbers suggest that we will have the labour force that could change the world. Our situation compares well with the industrialised world — as its labour force reduces by 4 percent by 2020 and that of China goes down by 5 percent, India's will increase by 32 percent. So as far as the age structure and potential are concerned, it's a huge competitive advantage and this is the time for us to seize that advantage.

These are promising statistics, but they demand proactive approaches to truly tap into their potential. Leaping towards a golden age of international interconnectivity, the Gulf Cooperation Council (GCC) countries are host to some of the largest numbers of migrant workers, who contribute greatly to the economic vitality of these nations. The vital aspect, as this displays, are the people and the movements they make. But, as I have said several times, ease of mobility, workforce advantage, and the demographic dividend will only work in our favour if we can educate and train our young people to seize the opportunities available to them in the 21st century. And there we are failing: 'skill development' has remained a *mantra* without a method, and the alarming drop-out rate from our government schools has not been compensated for by any significant increase in vocational training opportunities to cater to their needs.

The onus of harnessing our nation's potential, bringing about the social and economic transformation we have envisioned, requires leadership across all sectors of our economy. The greatest weapon in our national arsenal is the burgeoning entrepreneurial ambition which is now on the front-lines, especially in nations like India with their robust demographic potential. A distinctive 'Brand India' has already been achieved in part due to a phenomenal rise of Indian business possibilities, but even more so, due to the proliferation of micro, small and medium-level entrepreneurial ventures in the recent years. Some will succeed, and a number will fail, but they will all energise our economic spaces and throw up the best available minds and talents to lead the economy and to lead the country. We need to cultivate an

ecosystem of innovation, as the right mind-set is often half the battle won in finding the right solution.

However, to continue to overcome the challenges, unique and collective, that we face in this century and beyond, we must count upon the inherent creativity and spirit of enterprise in our nation. In evaluating our national experience and expertise, one gauges how small the world is, but how immense is the magnitude of the potential it holds. It is encouraging to see how case studies of Indian grassroots initiatives like the '*Dabbawallahs of Mumbai*' or '*Sulabh International*', or even innovative practices that were introduced into the Indian Railways (environment-friendly *kulhad chais*, innovative financial management) have all been introduced in the curricula of various institutions of higher education, not just in India but around the world, giving a taste to students of how indigenous business management practices have worked.

Our Indian principle of '*jugaad*' (a term for inexpensive innovation to solve problems) is becoming institutionalised. Critics give it a negative connotation as a method that people use just to twist their way around the system to get things done by cutting corners. I am also aware that some say *jugaad* is not good enough, because it is about simply 'making do' whereas we should be striving for excellence. But I think *jugaad* is much more than that. To me, it is about new ways of thinking out of the box, to re-purpose things, to make do with what you've got within your resource constraints, to create solutions for seemingly intractable problems, to think creatively about overcoming obstacles and most importantly, to bring non-traditional solutions to traditional issues.

Let me give you the example of an Indian villager who constructs a makeshift vehicle to transport his livestock and goods by rigging a wooden cart with an irrigation hand pump that serves as an engine. Common machines and household objects are reincarnated in ways that their original manufacturers never intended. Everything is reusable or re-imagined. If you cannot afford your mobile phone bills, you invent the concept of the 'missed call' – a brief ring that is not answered but that signals your need to speak to the recipient. During the summer, the demand for lassi goes up, and normal mixers are not enough for *Dhaba*-owners to meet demand. So one

Punjabi entrepreneur repurposed his washing machine into a gigantic mixer to make lassi, and now sells the stuff in vast quantities!

Another thing about *jugaad*: Instead of complicating or refining their products, Indian innovators strip them down to their bare essentials, making them affordable, accessible, durable, and effective. If you google the phrase 'frugal innovation', you will find that the first 20 hits all relate to India. We are path-breaking leaders in 'frugal innovation,' and, keeping in mind our poorest, we have systematised what can be called 'Innovation' (for Indian innovation) — achieving success within our local resource constraints. Indeed, working with the widest of opportunities at the bottom of the pyramid is the way up to becoming a super-economy. Our outlook towards innovation across the spectrum, textile to technology, community to commerce, has been such a trailblaser that, in 2011, the University of Toronto instituted a dedicated 'India Innovation Centre' on its campus, which continues to study innovation.

Indian entrepreneurial ingenuity has produced a startling number of world-beating innovations, none more impressive than the Tata Nano, which, at US$2000 (when it first came out on the market) or Rs 1 lakh, cost roughly the same as a high-end DVD player in a Western luxury car. Of course, there's no DVD player in the Nano (and no radio, either, in the basic model); but its innovations (which have garnered 34 patents) are not merely the result of doing away with frills (including power brakes, air conditioning, and side-view mirrors). Reducing the use of steel by inventing an aluminum engine; increasing space by moving the wheels to the edge of the chassis, and relying on a modular design that enables the car to be assembled from kits was in many ways groundbreaking. Though admittedly the Nano was not necessarily a marketing success (as its makers misjudged the prevalent perception of the ownership of a car in Indian society as a symbol of status rather than an engine of economic utility), it certainly proved that you could do more with less.

Similarly, the Indian Mission to Mars, *Mangalyaan*, cost approximately Rs 492 crores (US$70m), which was less than the budget of the Hollywood space movie *Gravity*! This was about 11 percent of the cost NASA incurred for its own latest Mars programme at Rs 4,500 crore (US$690m). Then there's the GE MAC 400, a handheld electrocardiogram (ECG) device that costs Rs 50,000 or less than US$800 (the cheapest alternative costs more than Rs 1 lakh or US$2000). The GE MAC 400 uses just four buttons, rather than the usual dozen, and a tiny portable printer, making it small enough to fit into a satchel and even run on batteries; it has reduced the cost of an ECG to just Rs 50 (less than a US$1) per patient, making it affordable to very poor Indians. Equally remarkable is the *Tata Swachh*, Rs 1,500 water purifier (ten times cheaper than its nearest competitor). The *Swachh* uses rice husks (one of India's most common waste products) to purify water. Given that some five million Indians die of cardiovascular diseases every year, more than a quarter of them under 65, and that about two million die from drinking contaminated water, these innovations have proved to be nothing less than groundbreaking. And they correspond to the real needs of real Indians.

That is also the distinguishing feature of the annual Mashelkar Award for Innovation, given by the eminent scientist in memory of his late mother. The very first prize was an example of rewarding an innovative solution to an Indian problem. About 15 million of our compatriots are blind, most for preventable causes. There are simple tests available for glaucoma and cataract, but they require the dilation of the pupils of the eyes, which lead to a fizzy vision for several hours afterward. The bulk of India's poor are daily wage workers, and if they can't

see for several hours they can't work that day; if they don't work that day, they have no income, and their families don't eat that day. So they avoid the eye tests, leading to increasing glaucoma and cataract, and eventually blindness. The first Mashelkar prize went to an Indian innovation that permitted eyes to be tested swiftly and cheaply without dilation. The innovation, now sold under the name 3-Netra, is a huge success and has enabled many poor people to take steps to ward off preventable blindness.

> "We need an international commitment to create generations of such individuals who can design quality solutions that can work across all these areas, create awareness, promote effective implementation and continually improve them as we go along"

My argument here is that thinking out-of-the-box, resolving colossal problems within limited resources, in touch with India's realities and necessities, with new innovative solutions is what we can really, truly call disruptive. The more we disrupt conventional ways of thinking, traditional methods of practice, and orthodox approaches to existing problems, the more we are likely to succeed. India gave the world the zero, all those thousands of years ago. But today, all we are inventing, it sometimes seems, is zero. That needs to change and we need to have more world-conquering, socially-useful inventions coming not just from India or California but from across the world.

Globalisation, which we see today as a commonplace term, offers us both challenges and opportunities. The end of the Cold War, the narrowing of global boundaries, and the communications revolution have rewarded us with globalisation. It is a complex, controversial and synergistic process, in which improvements in technology, especially in information technology and transportation have combined with the deregulation of markets, formulation of free trade agreements, liberalisation, the free flow of capital and open borders generally speaking, except for workers sadly, to bring about a vastly expanded flow of managers, money, goods, services, and information. This process at its minimum integrates people, businesses, non-governmental organisations, and nations into larger networks, and at its best promotes convergence, harmonisation, efficiency, growth, and, perhaps, even good governance practices around the world. For innovators, globalisation offers all the necessary ingredients for success.

But it has a dark side too. Globalisation produces economic and social dislocations. It arouses concerns over job security, the distribution of economic gains, the impact of volatility on families, communities, and

nations. Economic growth is vital, indeed indispensable. But the magic of the market where entrepreneurs can thrive will not appeal to those who cannot afford to enter the market place at all. We need to extend the benefits of globalisation and liberalisation to the poor and vulnerable by supporting growth and also distributing the fruits of that growth to those who have been excluded or marginalised, so that they too can become consumers and expand the market.

According to the latest Oxfam World Inequality Report, the assets of just 26 of the richest people in the world are more or less equal to the combined wealth of 50 percent of the world's population, who account for just 1 percent of total wealth, as indicated by the Credit Suisse Global Wealth Report 2018. A mere 1 percent of the fortune of the world's richest men is equivalent to the whole health budget for the country of Ethiopia, with 105 million. This great imbalance is the millstone around our necks, as leaders of industry and policy. We need to remember that even if our global growth rate is 3.6 percent, we cannot forget that the focus our development must be on the bottom 25 percent of the world who are currently living in extreme conditions of poverty.

As an Indian Member of Parliament, a former Minister of State for Human Resource Development, and as an international civil servant at the United Nations, I have had the privilege of interacting with many young people, potential future leaders. I have been impressed by their enthusiasm, enterprise, and the idealism that they have shown in dealing with problems exclusive to their country or shared between us all, and that is why I am hopeful that they will help identify quality solutions across the board to our long-standing international problems. These are problems that have not changed for decades. But our power of disruption has. Our problems of providing necessities to all our citizens, what was once famously phrased in India as *Roti, Kapda aur Makan* (food, clothing, and shelter) have now been elevated to *bijli, sadak aur paani* (electricity, roads/connectivity, and water) — and one can add *kitab, naukri* (education and employment) and perhaps these days broadband internet as well to the basic wish-list that every ordinary Indian or global citizen must-have. The exigency now is to find innovative ways to tackle these shortfalls.

In other words, it is time to set aside the old stereotypes of who can and cannot excel at what in our globalising world. In this new disrupted world, we need entrepreneurs who can lead, who can innovate, who can inspire, who can reach out beyond the limits that their forerunners have lived with and create systems that hold explosive potential for our mutual good. We need an international commitment to creating generations of such individuals who can design quality solutions that can work across all these areas, create awareness, promote effective implementation and continually improve them as we go along.

Today, it is important that we continue to venture into the world to display the unparalleled talent and intelligence of which Indians are capable, and set up challenging new endeavours. If this is done it will make significant contributions to the advancement of our knowledge-base and the economic-social growth of the world.

Mahatma Gandhi once said, "It is the quality of our work which will please God and not the quantity '. He, of course, more famously declared, 'Be the change that you wish to see in the world.' Since quality will not come without change, I think, both his exhortations apply here — to change ourselves, our patterns of thinking and our networks of creating, and to do so with work and values of the highest quality.

Adapted from his Keynote Speech to the Indo-US Entrepreneurs Summit, California, May 2019

Arun Maira
Former Member
Planning Commission
of India

Inclusive Innovation

Reinventing the Wheel

India needs to develop innovations that will produce more socially inclusive and more environmentally sustainable growth.

"Why do Indians want to reinvent the wheel?" a US businessman asked, in a discussion on innovation, at a US-India Business Summit in New Delhi in 2012. The US and other developed countries have found the solutions. India should open up its markets to Western solutions more quickly if it wanted to progress faster, he said. The response from the Indian side was, the US-designed wheel of progress is putting too much pressure on the Earth, and the cart is leaving too many people behind. That is why India needs to develop innovations that will produce more socially-inclusive and more environmentally-sustainable growth. Therefore, we must go back to the drawing board to rethink the purpose of innovation, the concept of innovation, and the governance of innovation.

The Purpose of Innovation

The Indian view was that the purpose of innovation must be to produce inclusive growth, more quickly and more visibly. Whereas the US model (sometimes described as the 'Silicon Valley model'), which has produced remarkable technological innovations, produces more billionaires and is increasing the distance between people at the top and the bottom of the pyramid. The belief is that more wealth produced at the top will provide more wealth to trickle down. The problem is that the pace of accumulation at the top has been exceeding the pace of trickling down, increasing wealth inequalities, not only in the US but in all countries that have adopted US-led concepts of innovation and economic growth.

The Concept of Innovation

Since the invention of the internet 30 years ago, followed by rapid advances in communication and computation technologies, 'innovation' has become associated in the public imagination almost entirely with 'technology'; and the term 'technology' with telecommunication and computation techniques. In this paradigm, a new 'app' to expedite delivery of pizzas with a smart-phone is celebrated as an

innovation, and its inventor expects investors to provide millions of dollars to sell it.

Beyond its association with information technology, innovation is also associated with intellectual property rights(IPRs). Pharmaceutical companies that make billions of dollars by selling new molecules, which are ring-fenced by intellectual property monopolies, ever-greened and extended for long periods, are called 'innovative' pharmaceutical companies. These 'innovative' companies prefer to invent medicines to improve the lifestyles of the rich who can pay high prices rather than discover drugs for treating the afflictions of the poor.

In this popular concept of innovation, its purpose has been reduced to the production of patentable products and services and to the production of profits for inventors and investors in their ventures. Whereas, a broader view of innovation reveals that greater impacts on business and society are produced by innovations in business models and forms of institutions. For example, the invention of the limited liability company has had enormous impacts on economies. And institutions of electoral democracy have changed shapes of societies more than any app on a smartphone can.

The Governance of Innovation

The US and India are champions of democracy. India is the world's largest democracy; and the US is democracy's global beacon, with its Constitution founded on the principle of 'government for the people, by the people, of the people'.

Capitalism and democracy are the two forces that have shaped economies and societies in most countries of the world since the collapse of the Soviet Union 30 years ago. These two forces operate on very different principles. Capitalism is based on the principle of property rights; democracy on the principle of human rights. In capitalist enterprises, your voting rights are based on how much you own. One dollar equals one vote; a million dollars equals one million votes. In a democracy, everyone rich or poor, whether they have a billion dollars or no dollars, is supposed to have an equal vote and an equal voice in how society is governed.

“Just as institutions of government must be reformed to create an inclusive democracy, institutions of business and capitalism must be reformed to create an inclusive economy”

Capitalism and democracy run on different types of electricity. If you plug an appliance designed for AC electricity into a socket that supplies DC electricity something will blow up.

Just as institutions of government must be reformed to create an inclusive democracy, institutions of business and capitalism must be reformed to create an

inclusive economy. Therefore, businesses must be not only For the People, they must also be By the People, and Of the People.

For inclusion, we need innovations to provide affordable and accessible goods and services, especially at the bottom of the economic pyramid. This is the business opportunity for 'profit at the bottom of the pyramid' that C.K. Prahalad wrote about, and that many entrepreneurs are pursuing. By producing products and services for poorer people, they can expand their customer base. For example, a shampoo sachet enables even poor people to buy a big company's products. The profit from the bottom of the pyramid goes to the shareholders of the capitalist enterprise.

But this does not address the root cause of poverty. People are poor, and cannot afford to pay much, because they do not have incomes. They need jobs and incomes to lift themselves out of poverty. Therefore, they must be engaged in the processes of producing goods and services for themselves and others. And therefore, we need innovations in production models that provide more jobs, so that Business is By the People too.

Employees in enterprises owned by others have incomes but do not have a share in the creation of wealth, the fruits of which will go entirely to the owners. For a fuller inclusion in the benefits of growth, we need more enterprises in which the producers and workers share the wealth created too. This requires innovations in enterprise design and governance models to shape the Businesses of the People.

Indeed, this was Mahatma Gandhi's vision. His spinning wheel was a symbol. In his vision for India, all people would-be producers of goods and services that the community and the market need. They would be earners and also owners of their enterprises, even if tiny.

Two areas of governance of economies that need innovation to make innovation more inclusive are the design of cooperative businesses, and the governance of intellectual property. Businesses owned by producers, rather than remote investors, will enable accumulation of wealth at the bottom of the economic pyramid. This will reduce inequalities of wealth between financial investors and workers, which is a principal reason for increasing wealth inequalities in India, the US, and elsewhere too, in the last 30 years.

Reform of the rules of IPRs will be more contentious, though essential to make innovation more inclusive. Governance of IPR must return to its original intent, which was to enable the spread of knowledge more rapidly, to enable innovators to build upon discoveries made by others, making technological progress faster and more inclusive. As a quid pro quo for sharing knowledge, inventors would be provided a reasonable period to recover their investment and earn a fair return. However, the rules of IPR have progressively been distorted to favour those who have IPR and wealth against those who do not yet have any IPR and wealth.

The wheels of innovation are ripe for re-treading to make economic progress more sustainable and inclusive. The US and India, the world's largest democracies must collaborate to lead the way.

Hyperlink a Grand Alliance

Pradeep S Mehta
Founder Secretary General, CUTS International

Robert D Atkinson
President, Information Technology & Innovation Foundation, US

If India and the US don't want to live in an increasingly bipolar digital world, it is time for a high-level digital alliance between India and the US.

With two of largest economies in the world — the European Union (EU) and China — developing their own digital economy frameworks and governance systems, and seeking to export those to their respective spheres of influence, the US and India risk being isolated.

With its comprehensive digital economy regulatory regime, including limits on cross-border data flows, onerous privacy rules and aggressive anti-trust enforcement directed at US internet companies, EU is seeking to export its digital governance model globally. China is doing the same.

China's strategy of a protected domestic market, coupled with a State that is a massive provider of data to Chinese IT firms, is being exported through its digital Silk Road initiative.

If India and the US don't want to live in an increasingly bipolar digital world — with some nations in the EU digital regulatory block and others as digital colonies of China — it is time for a high-level digital alliance between India and the US.

Today, the two countries are already partners in areas ranging from trade and investment, defence and counterterrorism, science and technology, and energy and health. Goods and services trade between the two countries topped $142 billion in 2018, with a joint resolve of taking it to $500 billion by 2024.

As India is a leader in IT services, fielding global leading companies like Wipro, Tata Consultancy Services (TCS) and Infosys, and the US is home to the world's leading digital economy firms, becoming partners in digital is the next logical step.

However, increasingly, economic policy in the two countries is fuelled by 'nation-first' rhetoric. Such an approach has the potential of putting both countries at loggerheads.

For instance, India's position on local storage of sensitive data of its citizens, particularly in payments, e-commerce and social media sectors, has raised the hackles of American companies, as have a series of restrictions against US firms from entering the ecommerce market.

Mutual Strengths Yet, apparent discord is no reason to weaken the resolve of deepening engagement in existing areas and expanding in others. In fact, such episodes must prompt a course correction through comprehensive review of causes, and designing of mechanisms to prevent and promptly resolve possible discords in future.

One key Indian position is primarily informed by the difficulty of its law enforcement agencies to get timely access to data of potential rogue elements that may be stored outside India.

Yet, rather than ban cross border data transfers to the US, a well-negotiated arrangement between the two countries that inter alia minimises restrictions on cross-border data flow, maintains high levels of data protection, and does not compromise the ability of GoI to access necessary data in genuine cases, will be a win-win situation for both countries.

Resolving these kinds of existing and potential disputes through formalised mechanisms like advance notification and structured consultation could go a long way in deepening the partnership.

However, the scope of digital alliance need not be limited to dispute resolution. The emerging new IT-based innovation wave is bringing stakeholders across jurisdictions closer than ever.

A range of intermediaries has emerged to increase convenience, safety, speed and economy of digital experience, within and across borders. Regulation on accountability, dominance, grievance redress and taxation in digital economy will need greater cooperation among governments than ever before.

India and the US can lead the way in working towards establishing best practices by entering into early engagements at senior government levels on these issues, under a broader digital alliance. The ongoing 2+2 dialogue on defence and security issues could be a good template.

The digital alliance can also benefit from close partnerships between industry and civil society of the two nations. Finally, each nation leads in certain areas, with India ahead of the US in programmes like smart cities and digital identity systems.

Also, India has taken important steps in fighting digital piracy, with the Delhi High Court's recent decision that provides a new tool for rights-holders to better protect the creativity tied up in their copyright.

Digital Partners

The US leads in broadband and progress to 5G and e-government. When it comes to these kinds of digital policy innovations, a formal partnership can help two-way learning and implementation with appropriate customisation.

India and the US are not only naturally placed to develop a shared global vision for digital economy, but they are also equally equipped to present an optimal alternative to the Chinese or EU approaches. The leadership in both countries needs to actively work towards achieving this before it's too late.

“India and the US are not only naturally placed to develop a shared global vision for digital economy, but they are also equally equipped to present an optimal alternative to the Chinese or EU approaches”

The article was published in Global Trade Magazine and The Economic Times, on June 10 & 21, 2019 respectively.

Frank Islam
Chairman and CEO, FI Investment Group

Secrets to Success for India's Budding Entrepreneurs and Startups

The question is what can be done to reduce the number of failures? What are the secrets to success for India's budding entrepreneurs and its business start-ups?

India is blessed to be the third-largest start-up economy in the world. Unfortunately, there is a curse that comes with that blessing. That is, as indicated in a 2016 report issued by the IBM Institute for Business Value and Oxford Economics, 90 percent of Indian start-ups fail within five years.

The question is what can be done to reduce the number of failures? What are the secrets to success for India's budding entrepreneurs and its business start-ups? There are many. But based upon research findings and my own experience as an entrepreneur, I would like to highlight a critical few.

The IBM/Oxford report cited the lack of innovation as the primary reason for failing start-ups. A 2017 report by KMPG India and the Confederation of Indian Industry (CII) cited innovation, along with scalability and digitisation, as one of the three pillars for building a sustainable business.

So, what does an entrepreneur do to innovate? Here is the surprising answer that

> "The focus for entrepreneurial innovation should be encompassing – considering potential improvements in the areas known as the seven P's of services marketing: Product, Pricing, Place, Promotion, People, Process and Physical Evidence"

Vivek Wadhwa, a noted American IT researcher, academic, writer and entrepreneur, gave in an article in the Washington Post on April 30: "In a video-conference hosted by Indian start-up website Inc42, I gave Indian entrepreneurs some advice that startled them. I said that instead of trying new things, they should copy and steal all the ideas they can from China, Silicon Valley and the rest of the world."

Wadhwa goes on to explain that the reason that Silicon Valley is the international leader and hotbed for information technology is that there is considerable 'knowledge sharing' as engineers move from company to company. He observes that tech giants such as Facebook and Apple borrow and build on the ideas of others.

The KPMG/CII report makes a similar point on innovation, stating: "Not all innovation is radical or breakthrough. Innovation can also be incremental, yet small materially significant changes to the current operating model or products or services."

I would extend that even further to recommendations that the focus for entrepreneurial innovation should be encompassing — considering potential improvements in the areas known as the seven P's of services marketing: Product, Pricing, Place, Promotion, People, Process and Physical Evidence.

Besides, based upon my experience as an entrepreneur who took an information technology firm, the QSS Group, that I purchased in 1994 for $45,000 and one employee — me — to sales of over US$300mn and 3,000 employees when I

- Believe in yourself and your business. Pursue your end goal with drive, determination and a passion to succeed.
- Find and focus on your niche market. Figure out early on who will be your target customer segments and key

customers within those segments and build your business model around them.

- Deliver quality products and services that exceed customer expectations. Merely satisfying your customers is not good enough. They need to receive the unanticipated to become loyal. This is as true for the neighborhood *kirana* stores as for Apple and Google.
- Surround yourself with talented people. Pay them well. Listen to them. Learn from them. And work closely with them. Remember, business is a team sport and not an individual one.
- Have no fear of failure. India is a market where investors have little tolerance for failure. But fear can be crippling. Put your faith in your plan and yourself and carry on.

While the strategies and tactics will differ given the nature of the business, I believe that addressing those five factors, along with the need for ongoing innovation, are cross-cutting and can be used by an entrepreneur to provide the framework for becoming successful in any start-up line of business.

There is no single formula for success, however, and the future is promised to no-one. Therefore, I will close with this final thought.

In a commencement address at Stanford University, Steve Jobs advised the graduates: "Your time is limited; so, don't waste it living someone else's life."

For budding entrepreneurs and owners of start-ups, I would modify Jobs' advice and say: "Your time is limited; so don't waste it trying to emulate someone else's business. Don't be a mere 'me too' business. Don't be a clone. Find your inner entrepreneur. Chart your path. Create a mission, vision and set of values that are unique to your enterprise. In other words, make it your journey. By doing so, you will define those secrets to success that will enable you to grow your small business of today into the big business of tomorrow."

The article first appeared in The Economic Times, on June 08, 2018

DISRUPTIVE AND DIGITAL INNOVATION LANDSCAPE IN FOCUS

Rita McGrath
Professor at Columbia Business School

M Muneer
Co-Founder and Chief Evangelist, Medici Institute Foundation

Gear Up to Lead Disruption in the Digital Era

What is visible is the ineptitude of Indian companies to lead disruption from inside out.

Just a year ago, one of the leading Indian telcos approached one of us to deliver a keynote address. Mission? Motivate executives in the wake of reddening bottom-lines and imminent layoffs induced by the Jio effect (Reliance Group had launched a disruptive mobile and data services that had severely affected the leading telcos). We marvelled at how lethargic and complacent these leading telcos had become even though they were cognizant of the Jio launch at least a year earlier.

What is visible is the ineptitude of Indian companies to lead disruption from inside out. While all the existing players imagined Jio to commence a price war, they were struck by a disruptive vicissitude in the unit of business itself: By making calls free (and nominal charge for data) in a market that so far focussed on telephone services, Jio created consternation for Airtel, Vodafone and Idea by igniting mass frenzy. Not content with a massive subscriber base in the shortest time ever, Reliance Jio took its disruptive juggernaut to related markets of mobile handsets and data services with the free phone offer and free Wi-Fi for college students.

Ever since the iPhone and the commercialisation of Android, the world has been reverberating from the radical changes brought by the smartphone. Cameras, GPS, watches, alarm clocks, music systems, TV, travel agents, banks and lately, even gyms, have faced disruption as customers are getting their "jobs done" via smartphone-enabled software. Incumbents are right to be worried about the next threat to their past competitive advantages. And yet, for most in India, the innovations that are essential to staying competitively relevant remain hostage to inertia, risk-repugnance, and the inheritance of copy-paste culture.

> “It is incomprehensible how few firms can make ongoing innovation an internal proficiency”

Disruption is everywhere: From telecom to retail, financial services to IT, and pharma to travel. Take for instance the banking and financial services industry (BFSI). With the regulatory thrust for better liquidity and digitisation post demonetisation, financial institutions need to think differently now more than ever. The sector is also seeing incursions into its traditional business by new entrants that are offering services that are either cheaper or delivered differently. Payments, share trading, money management, forex, investments and Portfolio Management Services (PMS) are all seeing the impact. From Bitcoin and Paytm to Bharat Interface for Money (BHIM) and Freecharge, India is following the world.

Disruption is at its every-day best in another industry, arguably the world’s biggest: Travel. Technology is making it easier for travellers to get information, compare prices and make their arrangements today. Third-party advice sites such as TripAdvisor, Yelp and Zagat make and break businesses – a few bad reviews can radically trim business. At the same time, new entrants such as Airbnb, Uber, and Lyft have the potential to replace today’s middlemen with themselves at the centre of the most critical transactions.

Increasing Competition and Decreasing Performance

It is incomprehensible how few firms can make ongoing innovation an internal proficiency. In the developed world, there is a continual decline in return on assets (ROA) in the last 40 years. The ‘topple rate’ – a measure of the rate at which companies lose their leadership positions – has increased by 39 percent. Share buyback and stock incentives are creating “profitless prosperity”, in which executives and investors reap rich rewards, while corporations are hollowing out basic capabilities. The tenure of companies on the S&P 500 has declined from 61 years in 1958 to 18 in 2012. Two decades from now, 75 percent of the S&P 500 companies will have turned over. The bottom line is that company leaders understand they need to innovate and adapt, but they seem to be stumbling on just how to make this happen in reality.

Most companies in India stick to a business model and execute against it repeatedly albeit shoddily. Worse, they pay only lip service to corporate entrepreneurship in finding “transient advantages” while their employees continue to ignore competition from other industries, the need to manage both cyclical and structural changes, and the need to obtain early warnings and make decisions faster at their peril.

The remedy to ride the disruptive wave is to mount disruption itself. We propose Discovery Driven Disruption (DDD) as a means to scout for opportunities or “transient advantages” and framing options. For most firms, the core business is largely about today’s offerings for today’s customers. The idea is that “Platform Launch or Horizon 2” is tomorrow’s potential core business. In the outer edges of uncertainty, or Horizon 3, are what Rita calls “options” – which are small investments an organisation makes today that give them the right but not the obligation to make future investments.

The DDD will help firms to draw their new strategy playbooks that will continually reconfigure, engage and disengage in new opportunities for horizon 3, allocate resources between projects deftly as options evolve, build innovation proficiency and entrepreneurial mindset. This will also lead to managing careers of employees in radically different ways akin to movie making. The DDD framework uses a five-step process viz., creating a climate supporting continuous opportunity-hunting, establishing the entrepreneurial frame, creating a well-stocked opportunity register, building real options, and driving adaptive execution.

Just as entrepreneurs orchestrate the opportunity to search and scale-up personally, DDD will pave way for "entrepreneurship". The process for establishing a frame involves working through certain expectations of various stakeholders and looking at what minimum revenue and Return on Investment (RoI) targets the firm will consider as a major win. Reverse income statements will analyse resultant possibilities. The opportunity register will inventory all new business ideas identified for funding and it will have a rich set of prioritised items. Companies may use tools such as Marketbusting, Consumption Chain and Attribute Mapping during this process. Just as in investing in financial options, real options reasoning involves making small investments that give you the right to make a decision later. The idea is to limit your downside exposure until the upside potential of the opportunity is demonstrated. In conjunction with limiting risk, an options approach allows you to create focus and strategic alignment across a portfolio of initiatives.

We would imagine a group like Tata that has been "experimenting" with innovation in multiple ways, to lead disruption in many industries globally. Instead, 70 percent of its profits come from just one company: TCS. The trouble is that most companies invest in setting up innovation teams, building incubation centres, sending teams to Silicon Valley and so on but do not follow a seamless approach as DDD or address systemic issues unique to India such as risk-aversion, the copy-and-paste culture and *jugaad*. The DDD adapts the "if-you-have-to-fail, fail-cheap-and-fast" policy that encourages more disruptive initiatives at lower downsides.

Bottom line: If you don't disrupt your own business, someone else will!

Robert D Atkinson

President, Information Technology & Innovation Foundation, US

The Task Ahead of Us

Transforming the Global Economy with Connectivity, Automation and Intelligence

The next wave of digital innovation is coming. Countries can welcome it, prepare for it, and ride it to new heights of innovation and prosperity, or they can ignore the changing tide and miss the wave.

The Next Wave of Digital Innovation is Coming

Economies are complex production systems with myriad subcomponent production systems around the world. Today, the most important and widely shared technologies are digital information technologies that have evolved from the mainframe and mini-computing systems of the 1960s and 70s. They include an array of personal computing devices, back-office servers, IT-embedded machines, and cloud-based services that are connected or dynamically provisioned to users over private networks or the Internet. But the world is now beginning to transform into a new kind of digital system, one that will not only build on existing devices and systems, but also increasingly will incorporate emerging technologies such as sensors, robotics, and artificial intelligence as they improve in price and performance. This next digital economy will be significantly more connected more automated, and smarter.

This pervasive connectivity, combined with machine-driven automation and intelligence, will signal a new era for the economy. While transformative, this next economy will not be the so-called 'Fourth Industrial Revolution'— a term some have embraced to trumpet an epochal transformation akin to the rise of steam power and electricity. Rather, these technologies represent more of an evolution of our current digital system; albeit one that will bring significant advances, particularly in applying digital technologies to the physical world and using software systems to generate intelligence.

Although this evolution could bring widespread economic and societal benefits, obstacles and challenges must be overcome to realise its full potential—and therefore government will have an important role. This primer briefly lays out the nature and benefits of the new technology system that is taking root; what is involved in both developing the new technologies and implementing them across most industries;

the implications for global competitiveness; the political economics determining the pace and extent of the evolution; and finally, the appropriate role for government to accelerate it.

Getting this right is critical for two main reasons. First, countries' competitive advantage in the global economy will increasingly be based on the extent to which they are home both to the industries that are developing these new technologies and to the industries that are adopting them, particularly in globally traded sectors. Second, nations that lead in adoption of these technologies will experience greater increases in living standards and quality of life. But success in both development and adoption of these new digital technologies is not assured; in fact, many forces today work against it.

Perhaps the most important policy question for any nation or region is whether and to what extent its economic policies are focused on overcoming obstacles and aspiring to be a leader in the next wave of digital evolution. Those that choose to do so will benefit from more competitive industries and a more prosperous economy.

Overcoming Global Competitiveness Challenges to Digital Implementation

- A central question regarding digital progress globally will be whether national desires to gain advantages in next-wave technology industries and traded-sector industries transformed by the technologies will spur progress or retard it.
- Virtually all nations are competing for an advantage in emerging digital traded-sector industries, from AI software to fintech to autonomous systems.
- Europe and Japan largely missed the last two digital transformations, in part because they remained wedded to the older technologies and only weakly embraced the new technologies and business models they enabled. China was a latecomer that closed the gap largely through unfair mercantilist policies that handicapped US leaders and favoured domestic champions.
- Today, most nations understand the evolving contours of the new digital system, and if they fail to capture competitive advantage it will likely be either for lack of broad-scale support for rapid transformation or because of a failure to execute effectively.
- Some of the things nations are doing to support next-wave digital competitiveness—including supporting skills development, digital infrastructures, research and development (R&D), and government adoption of digital technologies—is positive-sum and

> “Pervasive connectivity, combined with machine-driven automation and intelligence, will signal a new era for the economy”

helps both the nations themselves and the world.

- Some of the things nations are doing retards digital advancement globally. This includes imposing restrictions on cross-border data flows, lavishing subsidies that generate digital industry over-capacity, engaging in theft or coercing transfers of intellectual property, conducting overly aggressive antitrust enforcement, limiting foreign market access, and maintaining overly restrictive regulatory systems.
- Large economies, especially those of the US and China and potentially India—have significant advantages in next-wave digital development and adoption. This is partly because economies of scale, enabled by large integrated markets, are key to digital innovation. For example, having access to large data sets is useful for artificial intelligence. Large markets also enable companies in industries where there are high fixed costs in developing a technology (such as R&D) to gain sustainable advantages over competitors with access only to smaller markets.
- Many small nations have advantages related to agility, cohesion, coordination, and smaller-scale institutional, political, and bureaucratic hurdles to overcome. These nations have an opportunity to succeed by specialising in particular emerging digital areas. This is because the challenge in many emerging digital areas is one of coordination, including chicken-or-egg issues, wherein success depends on multiple players in an ecosystem acting together. Smaller nations are often better able to foster such coordination.

- A core area of competitive advantage is data: Nations that enable innovators to compile and access large public and private data sets, including personally identifiable data, generally outperform nations that limit data collection and sharing. This does not mean that nations with no privacy protections will gain advantage; rather, laws need to balance individuals' privacy needs and expectations with the broader societal need for data innovation—something the world's most stringent privacy regimes currently fail to do.
- The emergence of new technology eras in the past has almost always led to different firms and regions disrupting incumbent leaders. This could very well happen again with new firms potentially disrupting the established leaders, and with the geographic centre of gravity for the next wave of digital technology development shifting, perhaps to China. These geographic shifts could very well happen within nations. The last digital wave led to bicoastal leadership in the United States, with much of the heartland lagging. The next wave, with its increased focus on integrating "bits and atoms," could lead to a rebalancing of economic activity. Some traditional industrial regions could rebound, especially if there are favourable national and regional development policies.
- This raises a host of issues about the US digital leadership and the domestic prosperity that leadership enables. The US dominated most of the information technology components that drove past periods' evolutionary leaps, in part because of a long tradition of government support, including procurement and support for R&D. Maintaining that leadership now with much stiffer competition will be significantly more difficult than overcoming the competitiveness challenges from Europe and Japan in the 1980s and early 1990s.
- To the extent lagging nations seek to leap forward, they should aspire to leadership in emerging digital technologies (e.g., artificial intelligence, IOT, robotics, etc.), not past or current ones (e.g., cloud computing, Internet search, social networks, etc.), as the US and Chinese leadership in these areas is quite strong, if not overwhelming. It makes little sense for a nation to try to support the creation and expansion of its own Google, Baidu, Facebook, or Tencent, either by favouring its own champions or by attacking foreign champions. Nations should instead "skate to where the puck is going" by focusing on emerging industries where global leadership is not yet established.
- Successful nations will have the most competitive companies, the most skilled workers and entrepreneurs, and the best policy systems. Having one or even two of these components will not be enough.
- Nations that fall behind in developing and implementing next-wave digital technologies will suffer lower rates of economic growth.

Why Government Has a Key Role

- Markets and firms will play the biggest role in developing and implementing next-wave digital technologies. But governments need to remove institutional and regulatory barriers to implementation while encouraging citizens to embrace, not resist, digital evolution.

- Governments also need to actively support next-wave digital evolution by supporting R&D, digital skills, and digital infrastructures; transforming the operations of government itself; embracing global market integration; and encouraging the transformation of systems heavily influenced by government (e.g., education, healthcare, finance, transportation).

The Tasks for Government

- The role of government is straightforward: Make next-wave digital evolution a central policy goal. Governments that choose to do so will benefit from more competitive digital technology-producing industries and a more transformed and prosperous digitally-enabled economy. To do that, governments need to enact policies that support digital transformation and resist policies that limit it. While there are both broad and specific policy areas involved, and each issue area is complex, they all fundamentally boil down to a simple question: Will the policy spur digital transformation or limit it in favour of another goal?
- There is a large set of policy areas where the benefits are largely unequivocal. All governments should move forward expeditiously in these areas, such as in supporting digital skills; freeing more radio spectrum;[1] supporting broadband rollout to high-cost areas;[2] funding R&D; supporting voluntary, global, and industry-led digital standards; prosecuting cybercrime; enacting trade policies that prohibit data localisation and support foreign direct investment;[3] expanding and deepening e-government and open-data policies; and crafting industry transformation policies. While some of these policy areas might involve trade-offs with incumbent economic interests, they involve few trade-offs with competing social priorities.
- Perhaps the most straightforward step nations can take is to ensure their agencies and institutions of government are up to date, sophisticated, and deep users of existing and emerging digital technologies. Yet governments in most nations are falling further behind private-sector leaders.
- Where there are trade-offs with social issues, governments should favour next-wave digital implementation by designing policies that spur installation in ways that minimise trade-offs. Many policies affecting digital technologies can either help or hinder transformation, depending on policy design. For example, by limiting access to data and raising compliance costs, overly stringent privacy policies, such as the EU's General Data Protection Regulation,

> “Policymakers should be skeptical of claims that advancing social policy goals such as privacy protections can also spur digital innovation”

come at the cost of faster digital transformation.

- In almost all cases where there are trade-offs with social issues, policies can and should be designed to support digital implementation while still addressing social policy goals. For example, giving users the right to opt out of data collection will protect privacy while limiting negative effects on digital innovation. Other areas where policymakers should seek balance include net neutrality;[4] free speech and regulation of social media content;[5] protection of intellectual property;[6] copyright enforcement;[7] competition policy;[8] Internet platform policy;[9] industry subsidies;[10] patchworks of local and state versus national or supra-national regulation;[11] regulation of specific technologies (e.g., drones,[12] ride sharing,[13] and other gig and sharing-economy services); and algorithmic bias.[14]
- Policies that seek to regulate digital services to limit illegal or unethical activities do little or nothing to limit digital transformation (and in most cases advance it), but they achieve important social goals. These are issues policymakers should continue to actively pursue.
- Policymakers should be skeptical of claims that advancing social policy goals such as privacy protections can also spur digital innovation[15]. Policymakers and their civil society allies often frame regulatory proposals as "win-win," because they realise their chances of succeeding diminish whenever their policies are seen as hurting digital progress. But in most cases, including privacy, these "win-win" claims are false, especially when the policy proposals are rigid and poorly suited to the technology environment.
- Governments should eschew policies that limit digital transformation. Some policies, such as discriminatory taxes on digital services or companies, unneeded regulations, and technology bans e.g., on autonomous weapons,[16] ride-sharing applications, autonomous delivery robots,[17] self-checkout systems,[18] facial recognition systems,[19] and algorithmic decision-making[20] will severely limit next-wave digital progress.
- Policymakers should craft regulatory systems that do not unduly penalise companies for attempting to implement digital technologies in good faith, because successful implementation will require companies to take risks. As such, a key question is whether regulation will be punitive, especially for risk takers.[21] To date, digital industries have been lightly regulated, at least in the US, which has been a key factor in the success of the digital revolution. Abandoning this orientation and punishing all mistakes equally and severely, regardless of harm or intent, will slow digital transformation
- Policymakers and other elites need to encourage the public to support digital transformation. One of the biggest risks standing in the way of digital transformation is neo-Luddite opposition. Nations that embrace change, welcome technological innovation, and do not fall into the trap of paranoia toward "Big Tech" and emerging technologies will be more successful. Government officials and other elites need to embrace and advance an optimistic narrative about how digital transformation will lead to increased living standards and better quality of life, and actively counter self-

promoting fearmongers seeking to instigate techno-panics.[22]

- Policymakers need to support not just technological innovation, but also institutional innovation. IT and business in general are evolving together, which requires new management practices and new business models. This is true in government and non-profit sectors as well. As digital technology evolves, societies need to embrace not just the technologies, but also institutional innovation to enable new governance models. For example, 3D printing technology will likely lead to entire houses being printed, but unless local zoning and building codes are reformed, innovation will be limited.
- Policymakers need to avoid favoring politically influential incumbents. Existing firms and new firms, big and small, domestic and foreign, all can be digital innovators. Wherever possible, policymakers should enable innovators to enter markets.
- Policymakers and elites need to reject anti-technology narratives that hold, wrongly in most cases, digital implementation creates challenges such as inequality; loss of jobs and worker rights; addiction; surveillance; algorithmic bias and manipulation; cybercrime; social media coarseness and polarisation; lack of diversity; political bias; concentrated economic and political power; and tax evasion. The truth is, digital technologies are not the principal cause of most of these challenges; and where they contribute, measured responses can often provide effective solutions without harming innovation. However, falling into the trap of anti-technology groupthink will limit digital transformation, in turn making it much harder to achieve the very goals most critics of the digital technological innovation support, such as increased living standards, a cleaner environment, increased educational opportunity, and the like.
- At the end of the day, nations' success in embracing next-wave digital technologies will depend on a combination of awareness and strategic action. Each nation needs to ask itself where it stands on both fronts. Do policymakers truly understand the technologies and competitive strengths, weaknesses, opportunities, and threats they present? Such an assessment requires an honest, non-ideological evaluation, and a rejection of myths and self-reinforcing ideas that sound good but are in fact false.

Groupthink should not trump thoughtful, objective analysis, painstaking though it may be. In taking strategic action, are nations focused on learning from global best practices in the wide range of policy areas affecting next-wave digital technologies, and then ensuring they adapt those lessons to fit the realities of their own nations? Getting this right will have a significant, positive impact on the living standards and quality of life of future generations.

Abridged from a paper which was first published by Information Technology and Innovation Foundation in January 2019

Endnotes

1 Doug Brake, "Spectrum Policy and the EU Digital Single Market: Lessons from the United States" (Information Technology and Innovation Foundation, December 2015), https://itif.org/publications/2015/12/07/spectrum-policy-and-eu-digital-single-market-lessons-united-states.

2 This is assuming government funds do not support "overbuilders."

3 Nigel Cory, "Cross-Border Data Flows: Where Are the Barriers, and What Do They Cost?" (Information Technology and Innovation Foundation, May 2017), https://itif.org/publications/2017/05/01/cross-border-data-flows-where-are-barriers-and-what-do-they-cost.

4 Doug Brake "Why We Need Net Neutrality Legislation, and What It Should Look Like" (Information Technology and Innovation Foundation, May 2018), https://itif.org/publications/2018/05/07/why-we-need-net-neutrality-legislation-and-what-it-should-look.

5 Nick Wallace, "EU Should Not Make Platforms the Judges of Free Speech," *EU Observer,* March 29, 2018, https:// itif.org/publications/2018/03/29/eu-should-not-make-platforms-judges-free-speech

6 Nigel Cory, "How Critics of the 'TPP' Trans-Pacific Partnership Muddle Facts, Fictions and Fears," *Entrepreneur,* October 7, 2016, https://itif.org/publications/2016/10/07/how-critics-tpp-trans-pacific-partnership-muddle-facts-fictions-and-fears

7 Alan McQuinn and Daniel Castro, "Stopping Online Piracy Is Not Censorship," *The Hill Times,* February 14, 2018, https:// itif.org/publications/2018/02/14/stopping-online-piracy-not-censorship.

8 Widespread deployment of connectivity, automation, and intelligence will require vast sums of capital. In many cases, it will be large firms that will have requisite resources and capabilities to make these investments.

9 Joe Kennedy, "Don't Regulate Internet Platforms, Embrace Them," *Euractiv,* November 13, 2015, https://itif.org/publications/2015/11/13/don%E2%80%99t-regulate-internet-platforms-embrace-them.

10 Subsidies are often in support of connectivity, automation, and intelligence (e.g., providing subsidies to doctors to adopt electronic medical record systems), but can limit it—particularly the development of better technologies if they support firms that otherwise would not be viable in global markets. Doing so reduces overall profit rates and in turn reduces ability to invest in R&D.

11 In most areas of digital policy, including broadband, local and state government regulatory actions should be preempted, as the interests of these governments often are at odds with national interests.

12 Alan McQuinn, "Don't Rush to Regulate," *Washington Monthly,* October 30, 2015, https://itif.org/ publications/2015/10/30/dont-rush-regulate-drones.

13 Joe Kennedy, "Three Paths to Update Labor Law for the Gig Economy," (Information Technology and Innovation Foundation, April 2016), https://itif.org/publications/2016/04/18/three-paths-update-labor-law-gig-economy.

14 *Ibid*

15 Daniel Castro and Joshua New, "How Policymakers Can Foster Algorithmic Accountability" (Center for Data Innovation, May 2018), https://itif.org/publications/2018/05/21/how-policymakers-can-foster-algorithmic-accountability.

16 Alan McQuinn and Daniel Castro, "Why Stronger Privacy Regulations Do Not Spur Increased Interned Use" (Information Technology and Innovation Foundation, July 2018), https://itif.org/publications/2018/07/11/why-stronger-privacy-regulations-do-not-spur-increased-internet-use.

17 Daniel Castro, "'Ban the Killer Robots' Movement Could Backfire," *Computerworld,* November 13, 2015, https:// itif.org/publications/2015/11/13/%E2%80%98ban-killer-robots%E2%80%99-movement-could-backfire.

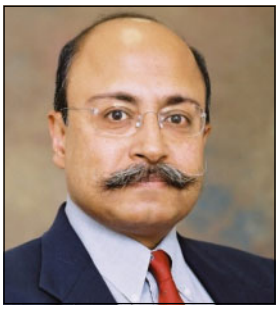
18 Alan McQuinn, "One San Francisco Official's War on R2-D2," *StateScoop,* August 21, 2017, https://statescoop. com/one-san-francisco-officials-war-on-r2-d2.

19 Daniel Castro, "Bill to Ban Sale of Alcohol through Self-Service Checkout Terminals Cloaked in Falsehood," *Los Angeles Daily News,* August 17, 2011, https://itif.org/publications/2011/08/17/bill-ban-sale-alcohol-through-self-service-checkout-terminals-cloaked.

20 New and Castro, "How Policymakers can Foster Algorithmic Accountability."

21 Daniel Castro and Alan McQuinn, "How and When Regulators Should Intervene" (Information Technology and Innovation Foundation, February 2015), https://itif.org/publications/2015/02/02/how-and-when-regulators-should-intervene.

22 "Daniel Castro and Alan McQuinn, "The Privacy Panic Cycle: A Guide to Public Fears About New Technologies" (Information Technology and Innovation Foundation, September 2015), https://itif.org/publications/2015/09/10/ privacy-panic-cycle-guide-public-fears-about-new-technologies.



Sumit K Majumdar

Professor of Technology Strategy, The University of Texas at Dallas

Digital Manufacturing Innovation

India's domestic market is potentially very large for embedded software items that alter the functionalities of other goods and services consumed by the public at large.

A principal cause of India's poverty, or rather a significant lack of economic success relative to her peers, has been due to her not ever being a manufacturing nation. Such a contingency fully impoverishes a country, and leads to de-industrialisation, as happened in India during colonial times. Well before such de-industrialisation, however, the inventor of computing Charles Babbage had written about India that: *"The cotton of India is conveyed by British ships round half our planet, to be woven by British skill in the factories of Lancashire: it is again set in motion by British capital; and, transported to the very plains whereon it grew, is repurchased by the lords of the soil which gave it birth, at a cheaper price than that at which their coarser machinery enables them to manufacture it themselves."* Of course, India got cheaper cloth, but the amount of lost wealth was immense. The inference is that a nation wishing to be rich must become skilled in the use of machinery and its economy is driven by the value addition emanating from manufacturing. India has lost out in energising the key driver of a country's development.

To be wealthy, a country must have participated in the scientific and industrial revolutions. There has been a direct relationship between scientific and industrial revolutions. Machinery and manufacturing processes have always incorporated the most recent and relevant scientific principles in their design throughout human history. Furthermore, the changes wrought by manufacturing-driven industrialisation have been transformational. Such changes are not merely scientific and industrial, but also social and intellectual. These changes have commercial, financial, agricultural and political ramifications. These changes could be revolutionary because they bring about intellectual changes that enable other changes to occur.

Modern manufacturing involves machinery usage. The usage of machinery is the primary approach towards engendering productivity for the same human effort. One of India's most distinguished post-independence civil

servants, the late H. M. Patel, had written: *"I will only make one rather an obvious point. A country with limited resources of men, money and material that wishes to improve its standard of living quickly must ensure that there is no wastage in the utilisation of its resources."*

Manufacturing matters in engendering productive resource utilisation. When an individual works with a machine, he engages in a transformative act. Often, some chemical and metallurgical processes change the raw material into something more valuable. There is a rearrangement of the key natural elements. Thereafter, the resulting product is combined with other rearranged items to create a final product completely different from the basic raw materials that the process began with. Hence, a transformative process alters the constitutive components into a product providing functionalities that constitutive components separately could not.

Embodied Knowledge

In engendering the transformative process, machinery within the manufacturing sector incorporates both embodied and embedded knowledge. These technologies have incorporated scientific principles. By definition, machinery makes work smart and reduces overall costs. That outcome is a function of the knowledge applied to the design of the machine, as well as of the intelligence embodied within the machine itself. Capital equipment, of which machinery is a key component, is valued not for the visible physical metal but the ideas embodied in the functionalities of the machine, and the activities then made feasibly.

This logic of embodiment can be taken further. The item or product, as generated by the use of machinery, will incorporate some or all of the knowledge originally embodied in the machine itself, though indirectly. Machinery in the manufacturing sector incorporates a considerable amount of intellectual capital, *a-priori,* and the work of each individual is influenced by this incorporated knowledge. As each works with machinery, not only is output enhanced by the contribution of such capital, but the quality of the human capital pool improves since it has now to work with physical capital that embodies knowledge. As such, the presence of a large manufacturing sector dramatically improves the human capital pool in an economy as a whole.

Embedded Knowledge

Nevertheless, it is the logic of embeddedness that is crucial for contemporary manufacturing-driven growth. An example serves best to make this

> “India is now a global information technology power, it can leapfrog other emerging economies into the newest generation of flexible digital manufacturing functionalities”

crucial point. While visiting a Bavarian Motor Works (BMW) plant some years ago, a unit was situated next to BMW's world headquarters, in Munich, I observed the manufacturing of the 3-series BMW cars in the plant. The plant is one of the oldest in the BMW family, and it is quite a small plant by BMW standards. It is situated next to BMW's main offices and research center, and the BMW World, which is a museum and display unit. It is located in what has become the congested residential and commercial northern part of Munich, near the Olympic stadium. As such, a plant such as this can hardly be considered as a serious source of manufactured goods.

But the statistics of the plant are central to my thesis. The plant is 400,000 square meters in size, though located in a small land area. The plant employs 9,000 persons. It operates three shifts in the press shop, where car bodies are made, and two shifts in the assembly operations. On average, 900 BMW 3-series cars are assembled in the plant daily, and the annual production of cars from the plant is over 200,000 cars. The annual production value is over $8 billion from such a small plant.

Because of space constraints, the assembly line, which in aggregate is almost four km long, is constructed on many levels. The plant consumes 600 tonnes of steel per day, made up of approximately 20 coils of steel. A coil of steel goes into the plant at one end, and it is cut and shaped into several bodies. About 66 bodies are cut and shaped by the giant presses located in the plant per hour, so that is over one body per minute. All of the body parts required for a car are then stored.

Subsequently, according to the production plan, then the required body parts, which had been stored for the interim, are brought together to be spot-welded to a 1/10th millimeter precision; then, other components are added, the body is married to the power train consisting of the engine and transmission, and a week later a finished BMW 3-series car emerges for sale anywhere in the world. The coil-to-car time for a coiled sheet of steel that has arrived at the plant is less than a week.

The plant makes every variant of the 3-series BMW car in the world. An assembly program at a particular time can consist of a very large variety of cars, with no one car ever similar to another. All cars are made only per customers' orders and there is no production for inventory. A customer can change the order up to 6 days before production commences. Each of the over 200,000 cars produced annually in that plant is unique. There is an infinite number of variations in the composition of the car possible, based on body style, steering wheel location, pollution requirements, number of doors, light placement requirements and many other features. Yet, the rejection rate of finished products is nil. An American visitor had asked what the rejection rate was, and the respondent did not understand the question as he did not know what rejection meant!

Digital Manufacturing Innovation

How does this happen? The explanation is that it is through the extensive use of information and communications technology and embedded software. The shaped body parts, which are cut from the steel coils, are generic. They are all based on the current product and model designs. These cut body parts are stored in the body shop awaiting assembly. Once an order is placed, a vehicle identification number (VIN) is given. After the generation of a VIN, everything is specific. Each car becomes unique. Based on a detailed product specification sheet, the production plan for several days is spelled out in advance. The specifications for each car, that have been digitally coded, are then placed in a digital transponder box for each car. The digital transponder box is a device containing the

specific details of each car. The processor in every digital transponder box has the same computational power contained in each Apollo space vehicle used on lunar missions. It is attached to the largest body part kept in the body shop that will eventually become part of a finished car.

Production is fully automated, though there are 3,000 employees per shift. These employees change tools and die, and keep a check on the quality. The plant uses 650 robots, in mobile production cells, with eight robots per cell on average. These robots can conduct operations on six planes or axes. Some robots can also operate along seven axes, the seventh axis being the lateral one. The robots are pre-programmed with specific instructions as to what to do when faced with a specific car variant. When a car of a particular variant, say a 4-door saloon car for the right-hand drive British market comes to a robot station for a specific bodywork task, the robot has explicit clear instructions, digitally embedded in its software, as to what operation to conduct for such a car and body style.

The production plan and every order variation are pre-programmed in the robots' software, and the digital transponder box associated with a particular VIN communicates with the robot so that exactly the correct operation required is carried out. Thus, the exact activity required is matched to model specifications. As the next VIN to be processed by a robot may be for a completely different order, say for a left-hand drive two-door convertible for the American market, the robot has to change certain tools, and these tool changes are carried out in five seconds.

Eventually, a completed 3-series BMW car will also contain twenty-two pounds of fiber optic cabling. It will contain forty different electronic controllers, coordinating and controlling every aspect of the automobile's operations. The production processes for the cars and the subsequent

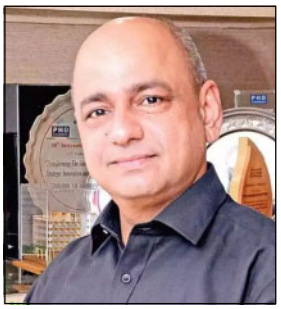
operations of cars in day-to-day ownership are based on embedded software. The embedded software has made the processes of manufacture and operational handling of BMW cars extremely efficient. Thus, BMW cars are justly prized for their build quality, handling and operations. The very high retail prices that BMW cars command are a function of the knowledge that has been embodied and embedded, via digital manufacturing innovations, in these cars.

Embedded software items are products that may not be visible when used for general purpose commercial or entertainment activities consumed *en-masse*. They are, nevertheless, digital goods used for the production of other goods and services in today's society. These embedded software items are ubiquitous in today's world. They are continuously updated and re-developed. The use of embedded software products is found in consumer items, manufacturing processes and service delivery processes.

A Digital Manufacturing New Age for India

India's domestic market, which is burgeoning in all sectors, is potentially very large for embedded software items that alter the functionalities of other goods and services consumed by the public at large. Embedded software will find a major market in modular new-age manufacturing processes in all types of manufacturing plants across India. India's companies have to immediately emulate the likes of manufacturing companies, such as BMW, so that India may become one of the key manufacturing nations of the world.

While it is too late for Indian information technology and software firms to become leaders in branded consumer software products, there are opportunities for firms to become global market leaders in specific embedded software domains. The intellectual energies of India's army of information technology and software professionals have to be channelised into embedded software development. Because India is now a global information technology power, India can leapfrog other emerging economies into the newest generation of flexible digital manufacturing functionalities. Based on embedded software product development, she can enter a new age of digital manufacturing. India can become a global player in producing embedded software products to create digital machines because this is what machinery with embedded software is. This *'digital manufacturing new age'* is the only way that India can become a rich nation, skilled in machinery use, and only then can her economy be driven by value addition emanating from manufacturing.



SP Sharma
Chief Economist, PHD Chamber of Commerce and Industry

Megha Kaul
Economist, PHD Chamber of Commerce and Industry

Transition from Industry 2.0 to Industry 4.0 in India

Challenges and Opportunities with special reference to Indo-US collaborations

Industry 4.0 is expected to transform existing technologies and capabilities in the manufacturing and industry sectors.

Industry 4.0

Industry 4.0 essentially refers to optimisation of smart and flexible supply chains, distribution models and factories where machines capture and provide data for making business quicker, ensuring efficient utilisation of all resources and maximising gains in minimall costs. The major components of Industry 4.0 are Additive Manufacturing,[1] Artificial Intelligence,[2] Augmented Reality,[3] Big Data,[4] Cloud Computing,[5] Cyber Security[6], Internet of Things (IoT),[7] Simulation,[8] System Integration,[9] among others.

Industry 4.0 is expected to transform existing technologies and capabilities in the manufacturing and industry sectors. It is an amalgamation of traditional manufacturing with state of the art technology to provide real visibility of the complete value chain allowing for better decision-making to lead to greater efficiency in the production process.

The various benefits that accrue to the manufacturers with the adoption of Industry 4.0 are as under:

i. Higher returns to businesses through cost reductions and efficiency: Digitalisation of manufacturing processes can ensure decentralised decisions, thereby reducing delays and enabling faster processes. Thus, with better utilisation of resources, digital technologies would ensure increased efficiency, reductions in turn-around time and subsequently reduce the cost

of production processes, thereby increasing cost-price margins to the firms.

ii. Value addition: Digital manufacturing technologies, such as 3D printing, laser cutting and robotic assembly enable the production of goods in small batches, thereby facilitating better customisation and value addition.

iii. Health and safety of workers: Digital technologies can enable elimination of the need for human presence and intervention in certain high-risk tasks and environments, thus facilitating the manufacturers to avoid exposing their workers to health hazards and reduce fatalities in the factories.

Opportunities to India from Industry 4.0

Currently, the manufacturing sector in India contributes around 17 percent to the GDP from the last five years which is well below the average share of the manufacturing sector in the GDP in many developed and emerging economies. This is because the manufacturing sector has been plagued with various challenges that impede its growth. Apart from structural challenges, these challenges range from lack of state-of-the-art infrastructure; unease in doing business due to high cost of capital, unavailability of land, stringent labour laws; unavailability of skilled workforce; low level of research and development and unavailability of high-end technology to introduce innovations and solve basic problems in the production processes.

> “With increased digitalisation and adoption of Industry 4.0, new skills required for jobs would evolve”

These issues can be addressed by Industry 4.0 as it has the capability to lead to higher efficiency, thereby leading to an expansion of production possibility frontiers of the firms. The digital technologies that form the core of Industry 4.0 would enable the manufacturing units with valuable data to give insights on customer profiling, the type of products in demand, the quantity in demand and the supply profile. The 4.0 vision would facilitate in providing connect that goes beyond the manufacturing plant walls. This would allow the customer to have complete visibility of the manufacturing process, thereby making the system more transparent, interactive and efficient.

The application of digital technologies in infrastructure projects would speed up the development of state-of-the-art infrastructure. These technologies can provide effective solutions to project management systems, building smart cities, building smart highways and effective management of freight logistics, thereby giving a push to industrial and economic growth, going forward.

A reliable, robust and efficient logistics sector is essential for the growth of industry and making Indian goods competitive in the international markets. The logistics cost in the country is as high as 13-14 percent of the GDP, in comparison to eight percent in the US and nine percent in Europe. India’s ranking in the Logistics Performance Index of the World Bank has declined from 35th

in 2016 to 44th in 2018 out of 160 economies. India ranks low due to slow transit time for the movement of cargo through road and shipping networks due to lengthy custom clearances procedures, unavailability of well-developed infrastructure, among others. The Ministry of Finance estimates that a 10 percent decrease in indirect logistics cost could increase exports by 5-8 percent.[10]

The application of digital technologies in the logistics value chain can facilitate route optimisation, live updates on the status of shipments, informing about traffic conditions and real-time inputs on the loading of trucks to ensure efficiency and better delivery. The usage of various technological tools such as Blockchain,[11] automated booking and algorithmic prices would give substantial results in the transportation process, thereby providing significant gains to the manufacturing and industry at large. Further, digitalisation can contribute significantly to the manufacturing sector by modernising the manufacturing processes and optimising the business cycles, thereby creating higher value and new business offering which could stimulate the growth of the sector, going forward.

Thus, with innovation in production processes, optimum utilisation of resources, application of hi-tech tools supported by enabling infrastructure and research ecosystem, it is estimated that the end-to-end digitalisation of the factory can lead to a rise in the productivity from around 12 to 20 percent. Currently, the average manufacturing sector growth is 10 percent (at current prices for FY18 and FY19), assuming the 12-20 percent increase in manufacturing productivity leads to an average growth of 14 percent of the manufacturing sector (at current prices) and assuming nominal GDP to grow at 12 percent, the manufacturing output is expected to more than double from the current level of around US$400bn to around US$900bn in 2024-25.

Further, the share of the manufacturing sector in the GDP is expected to increase by an additional 2 percentage points in FY2025. With the rise in productivity, ample

employment opportunities to the tune of around 12-14 million[12] would be created in the manufacturing sector in the next 5 years to cater to the growing job market effectively as more than 8 million jobs are needed in the country every year to keep the employment rate constant.[13]

Thus, with the implementation of digital technologies in the manufacturing and industry sector, the share of the manufacturing sector in the GDP would increase by an additional 2 percentage points in the next 3-4 years to create higher employment opportunities for the growing workforce.

Challenges of Industry 4.0

The benefits of Industry 4.0 are widespread for the Indian economy if implemented in true letter and spirit. However, there are a few challenges in the implementation of Industry 4.0 in the Indian manufacturing processes. At the macro-level, there is a need to develop an enabling infrastructure to support the adoption of digital technologies by the industry.

Thus, to build a conducive infrastructure, the present government has taken various reform measures to usher Digital Revolution in the country and accordingly Digital India Programme was launched on July 01, 2015. A National Rural Internet and Technology Mission for services in villages and schools, training in IT skills and E-Kranti for government service delivery and governance scheme has been initiated by the government. In the Union Budget 2019-20 also, the government has taken a slew of measures to promote digital payments in the country. The government has proposed to levy Tax Deduction at Source (TDS) of two percent on cash withdrawal exceeding Rs 1 crore in a year from a bank account. Further, to encourage digital modes of payment, the government has proposed that the business establishments with an annual turnover of more than Rs 50 crore shall not charge or provide Merchant Discount Rate to customers as well as merchants using low cost digital modes of payment.

These reform measures are giving visible fruitful outcomes as over two crores rural Indians have so far been made digitally literate under the *Pradhan Mantri Gramin Digital Saksharta Abhiyan*. Further, to bridge rural-urban digital divide, Bharat-Net is targeting internet connectivity in local bodies in every Panchayat in the country.[14]

These measures at the macro-level are a step in the right direction and have to be matched with the pro-active initiatives of the business firms to identify and utilise the vast amount of opportunities provided by digital technologies in their business applications.

The manufacturing firms must prioritise identifying the right digital technology for their businesses and invest in them to smoothen and fasten the entire value chain and augment decision making. There is a need to upskill the talent within the factories and industry by investing in capacity building to make them job ready in the dynamic industry scenario.

There is a widespread belief that Industry 4.0 is expected to disrupt labour markets in the country. These impacts, however, will be felt in niches. The broad structure of Indian labour markets is unlikely to change in any significant way in the next decade[15]. There are various reports which have estimated the potential impact of digital technologies on job scenario in India. A report by McKinsey[16] notes that the economy can create enough new jobs to offset the automation and employ more workforce. The report further notes that there would be a mass shift of workers to different sectors and occupations, instead of a mass job displacement driven by the adoption of digital technologies.

It may be noted that various reports state that the workforce in India is not job-ready. The India Skills Report 2019 states that only 47 percent of the graduates have employable talent. Though this is an increase of over 15 percentage points in the last 5 years, there is still a wide scope to increase the number of employable talent in the country. Thus, the government has to make concerted efforts to identify the skills required by the industry, the gaps in skilling and direct the institutes to alter their curriculum according to the industry requirements and changing economic environment.

Thus, with increased digitalisation and adoption of Industry 4.0, new skills required for jobs would evolve. On the macro-front, an overall policy shift is required with changes in the education curriculum complemented with reforms in labour laws and business regulations and ensuring education, skilling and work opportunities for all.

Opportunities for Indo-US Collaborations for Adoption of Industry 4.0 in India

At this juncture, it becomes imperative that the general consensus of the policymakers, business firms, think tanks and organisations need to shift towards ensuring smooth adoption of Industry 4.0. According to the World Economic Forum's Future of Production Readiness Report 2018, India displays a low level of readiness for the future of production as it is considered a Legacy Country.[17] Legacy countries face the risk of losing traditional manufacturing shares to other countries that can offer even cheaper labour. Hence, the economy must gear up to invest significantly in technology developments to control premature de-industrialisation.

As identified in the previous section, the government needs to build its Human Capital base and develop state-of-the-art infrastructure to facilitate the industry and the manufacturing sector to integrate digital technologies in their business applications. The collaborations with the US economy can provide greater benefits to the economy as the US economy has been marching towards Industry 4.0 with full vigour and enthusiasm.

The India-US bilateral relations have evolved into a global strategic partnership as both the nations share democratic values with the increasing convergence of interests on bilateral, regional and global issues. The ever-expanding dialogue and regular exchange of high-level government visits

have established a sound framework for India-US engagement in various fields ranging from agriculture, cybersecurity, defence, education, environment, energy, health to trade and investments and science technology.

India's bilateral trade in goods with the US is growing rapidly from 13 percent in 2017 to 21 percent in 2018. The volume of trade with the US has also increased significantly from US$62bn in 2016, US$70bn in 2017 and to US$85bn in 2018.

The share of the US in India's bilateral trade in goods has increased from nine percent in 2017 to 10 percent in 2018 whereas India's exports with the US grew by 13 percent and India's imports from US grew by 38 percent in 2018.

The India-US Science and Technology Cooperation has been growing steadily under the the US-India Science and Technology Cooperation Agreement signed in October 2005[18]. The Indo-US Science & Technology Joint Commission is co-chaired by the Union Minister of Science and Technology in India and the Science Advisor to the US President. India-US Science & Technology Forum (IUSSTF) was formulated in 2000 to support and foster joint applied Research & Development to generate public good through the commercialisation of technology developed through sustained partnerships between the US and Indian researchers and entrepreneurs.

Further, the US government in 2016 announced financial support of US$121mn for expansion of low cost and rapidly scalable wireless broadband networks across India. This is expected to provide wireless Internet access to around 6.5 million residential subscribers.[19] Recently, a US tech-multinational signed an agreement with Niti Aayog to take forward the Atal Innovation Mission[20] and to develop use cases for 5G in services for the citizens and modernisation of the transportation network.[21]

Snapshot of Opportunities for Indo-US Collaborations for Adoption of Industry 4.0 in India

S.No.	Areas for Collaboration	Opportunities
1	Upgradation of Infrastructure through technology transfer	The US has a huge opportunity, particularly in the rural areas which constitute 67 percent of the population inhabitation and has low internet penetration, to develop and modernise the existing digital infrastructure
2	Skill Development	There is a massive need for upskilling and reskilling of the Indian workforce to make them digital-ready. The US can, therefore, leverage this vast opportunity by providing opportunities for skilling by developing sector-specific training modules and implementation of best practices in skilling.
3	Promoting Cyber-Security	The increasing implementation of digital technologies would require security and protection. The US firms dealing in cyber-security have a huge scope in India. This can be promoted by Consortiums for developing partnerships between US firms and Indian firms as well as Central and state government machinery.
4	Collaborations with Start-ups	The Start-ups have come up in a big way in the India Industry ecosystem. The US firms can tie-up with the manufacturing start-ups for technological upgradation, support and sharing of best practices.
5	Digital Payments	The US firms can collaborate with Indian companies for technology transfer and adoption of Digital Payments in India

These collaborations can be useful in facilitating India to adopt Industry 4.0 and foster the high growth of the manufacturing and industry sector at large. The Network Readiness Index[22] 2016 ranks the US at 5th position while India is ranked 91 out of 139 countries. According to the World Economic Forum's Global Competitiveness Index 2018, USA ranks 1st out of 140 economies while India ranks 58th. The US is the closest economy to the frontier of the Global Competitiveness Index, with the country taking a lead in the Business dynamism pillar, labour market and financial system pillars and has achieved a good score in the Market pillar. All these factors contribute to the country's vibrant innovation ecosystem, making it a 'super innovator'.[23]

The US is characterised with state-of-the-art technology and a conducive environment for the growth of research and development that has promoted innovation in the economy. For every US$1 spent in manufacturing, another US$1.89 is added to the economy, where it has the highest multiplier effect of any economic sector. The government realises the importance of Industry 4.0 for leapfrogging into the future. Thus, in 2011, the US President Barack Obama announced the formation of the Advanced Manufacturing Partnership (AMP), a national effort to bring together universities, industry and the government to invest in the emerging technologies for creating high quality manufacturing jobs and enhancing global competitiveness.[24] Thus, the US government is pursuing an aggressive policy to support the new development path of manufacturing and ensure the ability to innovate and invest in the US, promoting 'Made in the US' brand.

The report titled 'Industry 4.0 Market & Technologies: Focus on the US – 2018-2023' forecasts that the US Industry 4.0 market will grow at a CAGR of 12.9 percent.[25] The US is pursuing Industry 4.0 aggressively as the US manufacturers are seeing a real return on investments with increased productivity, mitigating risks with better quality control from new techniques.

The US manufacturers continue to step up investments in their operations in 2019. Further, the private equity interest in US manufacturing firms developing Industry 4.0 technology is growing. According to the International Federation of Robotics, the adoption of robotics in the US industry continues to grow, as it was revealed in its 2018 World Robotics Report that there was a six percent increase in industrial robot installations to 33,192 units in the US. This was driven by a rising demand to automate production, keep manufacturing in the US and in fact re-shore from abroad.

Thus, India stands to learn immensely from the Indo-US collaborations, particularly in Science and Technology. Consequently, the government may utilise its present India-US Science & Technology Forum (IUSSTF) to engage in an effective dialogue inviting Indian entrepreneurs and representatives from leading manufacturers in the US to come on a shared platform (Seminar/Conference/Symposium) and share their views and best practices for adopting Industry 4.0 in India. The IUSSTF can further act as a facilitator by forming a Consortium of industries from the US which are pioneers in Industry 4.0 and Indian manufacturers which are working towards integrating technologies in their business applications.

The Indian government may partner with US firms and invite the leading digital firms of the US to come and set up digital infrastructure in India. These American firms may be provided with incentives in terms of a tax cut for R&D spending for implementing their technical applications in the country. The Science and Technology Department of the Ministry of Science and Technology in India can work in close coordination with these American firms to ensure speedy delivery of the much-required infrastructure to support digital technologies. Further, the government can

> The Indian government may partner with the US firms and invite the leading digital firms of the US to come and set up digital infrastructure in India

facilitate skill development of workforce in India by tying up with the Skill Development Centres in the US. The American institutions would provide technical know-how and upskilling of the Indian workforce required for digital technologies, thereby enhancing capacity development in the workforce in the country.

Conclusions and the Way Forward

Industry 4.0 is the new game-changer and has begun to revolutionise the entire global ecosystem with significant changes witnessed across the world. The Industrialisation in India has undergone remarkable changes and the policy focus of the government has changed accordingly. Presently, the government aims at increasing the share of manufacturing in GDP. Industry 4.0 is the answer to achieving this gigantic shift in the manufacturing share in the GDP from the current level of around 17 percent. There is a vast literature that supports the idea that the manufacturing sector in the country would grow remarkably through Industry 4.0. Further, high returns to business through cost reductions, value addition and safer workplace are the other major benefits.

At this juncture, it may be mentioned that Industry 4.0 poses a challenge to job creation in the country. However, the broad structure of Indian labour markets is unlikely to change in any significant way in the next decade. In addition, new jobs would be created that would require new competencies and new skillsets. The right sets of skills to perform the tasks are becoming complex and would evolve further, requiring present and future generations to train and re-train, going forward. Soft skills such as communication skills, teamwork and management are likely to grow in importance in the emerging world.

Further, the state-of-the-art infrastructure needs to be developed to support the fourth revolution of industrialisation. The financial infrastructure must also be strengthened in the economy in order to move towards a less-cash economy. The MSMEs in particular need to be supported in terms of easy access to capital in order to support the digital infrastructure and ensure that they are part of India's digital growth story.

In addition, the government needs to ensure strong cyber-security and intellectual property laws in order to safeguard the inventions as well as innovations made by the industries in the country. Thus, there is a gigantic plan of action that the government needs to implement to accelerate industrial growth, thereby fostering innovation and spillover effects on each and every sector of the economy. The government may seek facilitation from economies like the US, which is a leading nation in the implementation of Industry 4.0. The

government can leverage the synergies developed over the years with the US and utilise the partnerships made in the recent times to develop consortiums and sign MoUs for sharing of best practices and technical know-how between the business establishments in India and US.

Above all, a holistic approach to adopting Industry 4.0 would be required to transition from Industry 2.0 for the benefit of not just the industry and manufacturing sector, but also the entire nation.

Endnotes

1 Additive manufacturing is used in small batch applications or for the production of individual parts or customised products. It is used directly with the customers or by suppliers to improve designs for increased performance and cost efficiency.

2 Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction

3 Augmented Reality provides real time information in an effective manner such as using simulations and 3D views to allow people to interact with electronic systems

4 Big Data refers to large volume of structured, semi-structured and unstructured data that can be mined to produce interesting insights to improve the performance of businesses exponentially.

5 Cloud Computing refers to on-demand availability of computer system resources particularly storage of data and computing without direct active management by the user.

6 Cybersecurity is the protection of internet-connected systems, including hardware, software and data, from cyberattacks.

7 Internet of Things describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices.

8 Simulation is the approximate imitation of the operation of a process or system which helps in assessing the scenarios for developing cost effective measures for production

9 System integration (SI) is an IT or engineering process or phase concerned with joining different subsystems or components as one large system. It ensures that each integrated subsystem functions as required.

10 "Industry and Infrastructure", in Economic Survey 2017-18, Ministry of Finance, Government of India, January 2018

11 The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value

12 Authors' calculations

13 World Bank's South Asia Economic Focus Spring 2018, Jobless Growth

14 Union Budget 2019-20 Speech

15 ILO, June 2018

16 James Manyika, Susan Lund, Michael Chui, JaquesBughin, Jonathan Woetzel, Parul Batra, Ryan Ko and Saurabh Sanghvi, "Jobs Lost, Jobs Gained: Workforce Transformations in a Time of Automation," McKinsey, December 2017

17 Legacy country refers to those countries which benefitted immensely from globalisation as they received high foreign direct investments due to low labour costs which helped them strengthen their structure of production.

18 Ministry of External Affairs

19 FACT SHEET: U.S.-India Economic Cooperation and People-to-People Ties. Retrieved on 22nd August 2019

20 Atal Innovation Mission is a flagship initiative of the Government of India to develop new programmes and policies for fostering innovation in different sectors of the economy

21 Pace, breadth of digitalisation in India is unmatched, Times of India, September 21, 2018

22 World Economic Forum

23 Klaus Schwab, World Economic Forum, The Global Competitiveness Report 2018

24 https://obamawhitehouse.archives.gov/the-press-office/2011/06/24/president-obama-launches-advanced-manufacturing-partnership

25 https://www.prnewswire.com/news-releases/the-us-and-china-invest-heavily-in-industry-40-technologies-to-be-the-worlds-largest-manufacturer-300589461.html

Vivan Sharan
Partner, Koan Advisory Group

Yamini Jindal
Economics Associate, Koan Advisory Group

Fostering Innovation-based Manufacturing

Achieving optimal outcomes necessitates the adoption of a holistic, innovation-based development model involving transfer, absorption and incubation of technology, all of which can be accelerated with US participation and support.

Introduction

Advancing bilateral relations through digital economy manufacturing collaborations is mutually beneficial to the US and India. One specific area where complementarities are yet to be fully realised is in new electronics value chains. This chapter shall identify various interventions that are essential for making India an electronics innovation hub, with a specific focus on the role the US can play. Smartphone manufacturing will be used as a reference to substantiate the mutual benefits that the countries can derive by deepening their participation in electronics value chains.

Smartphones and their components (including high-value parts such as semiconductors and Printed Circuit Boards) serve as critical last-mile infrastructure for a well-functioning digital economy. In recent years, India has focussed on localising smartphone manufacturing. However, evidence shows that its tariff-based development approach has failed to catalyse the envisaged local ecosystem. Achieving optimal outcomes necessitates the adoption of a holistic, innovation-based development model involving transfer, absorption and incubation of technology, all of which can be accelerated with US participation and support.

India's Phased Manufacturing Programme

Electronics imports account for the second-largest component of India's trade deficit after oil and mineral fuels. In 2018-19, more than half of the deficit from the

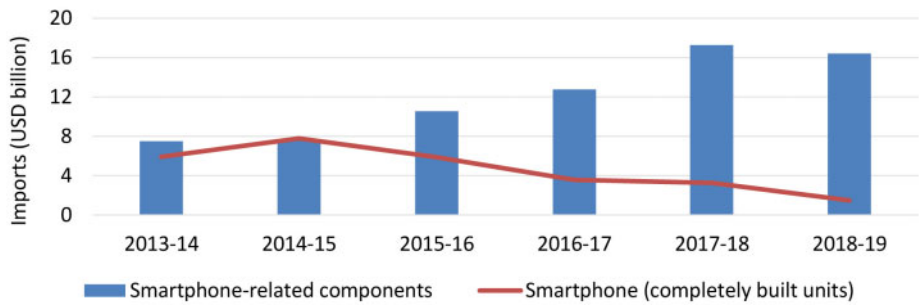
import of electronics was on account of smartphones and related components. Notably, several high-value components used in smartphones are widely used in other segments of the electronics industry. Therefore, localising manufacturing of smartphone-related components is a lever to achieving a greater comparative advantage in new electronics supply chains. Local manufacturing of high-value smartphones parts such as printed circuit boards (PCBs) and semiconductors, which are core components in several electronic devices, is particularly important. Moreover, the Indian Government has recognised that developing local manufacturing capacity in semiconductor technologies is of national security importance as well.[1]

The Digital India initiative identifies electronics manufacturing as a central pillar, within which smartphone manufacturing is a large subset, owing to large domestic market demand. To promote and incentivise local manufacturing of smartphones, the government has taken a tariff-led approach. This started with the announcement of a duty regime in the 2015-16 Union Budget. A countervailing duty (CVD) of 12.5 percent on imported handsets and an excise duty of 1 percent without input tax credit on domestically manufactured handsets were imposed – to introduce differentiation in treatment between local and imported handsets.[2] Additionally, imported components/sub-components were exempted from basic custom duty and CVD/excise duty. However, this initial approach failed to catalyse local manufacturing and only led to the proliferation of Assembly, Programming, Testing and Packaging operations, which capture limited value addition. For instance, Pathak et al. (2016) state that the assembly of imported semi-knocked down level components captured a value addition of only 6 percent.[3]

Recognising the failure of its initial approach, wherein imported components were not charged additional duties but imported handsets were, the Ministry of Electronics and Information Technology (MeitY) notified the Phased Manufacturing Programme (PMP) on 28 April 2017. Under the PMP, imports of components/sub-components were subject to customs duties in a phased manner (starting from low-value and gradually moving to high-value components).[4] However, the PMP too failed to achieve desired outcomes. While imports of smartphones decreased by 75 percent, imports of smartphone-related components increased by 119 percent – offsetting all gains (Figure 1).[5]

A 15 percent duty was levied under the first phase of the PMP on components such as chargers/adapters, battery packs and wired headsets. Consequently, compared to the year preceding notification of the PMP

Figure 1: India's Imports of Smartphones and Smartphone-Related Components



Note: Values are Inflation-adjusted; Source: Export Import Data Bank, Directorate General of Foreign Trade, Ministry of Commerce and Industry

(2016-17), the imported rate per unit of these components declined by 46 percent for chargers, 37 percent for batteries and 5 percent for wired headsets in 2018-19. This indicates that offshore suppliers managed to absorb the tariff shock imposed by the PMP by adjusting margins on these components. It is also important to note that the components covered in the first phase of the PMP contribute only a small proportion to the overall manufacturing cost of a smartphone, and thus suppliers were able to absorb additional tariff costs by reducing margins.

Another challenge has been the lack of focus on exports in the PMP, which has stymied local manufacturing. From the all-time peak of US$2.7bn in 2012-13, India's smartphone exports almost halved to US$1.4bn in 2018-19 (Figure 2).

The failure of successive tariff regimes to localise low-value components demonstrates that localising higher value components may prove even tougher. Part of the reason for this is that high value components are typically produced in countries that are already part of Global Value Chains (GVCs) for electronics. These are countries like Japan, South Korea, Taiwan, the US and China. High-value components require significant local research and development (R&D) focus and therefore are produced in bulk in such countries and exported to different parts of the world. By limiting the focus of the PMP to import substitution, India has precluded itself from catering to the global market for smartphones, as evidenced by the decline in exports. Adoption of an innovation-based lens is critical for India to be a meaningful part of electronics and smartphone GVCs, which in turn, requires incentives for global companies to localise in India.

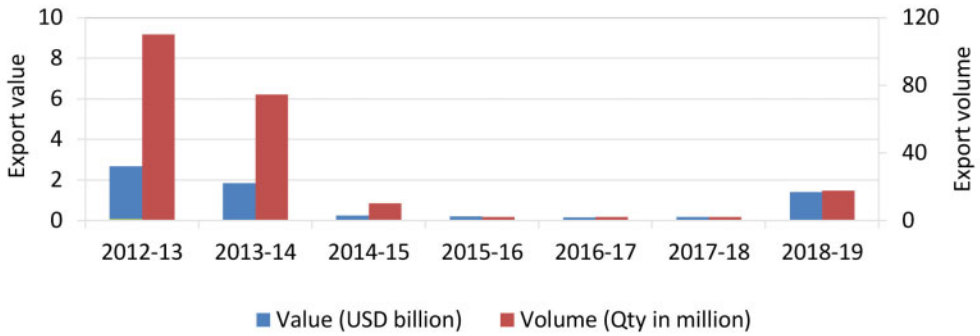
Towards an Innovation-based Development Model

The US can play a vital role in accelerating India's transition into an innovation hub at every associated stage of supply chain development, including transfer, absorption and incubation of technology. This is detailed below.

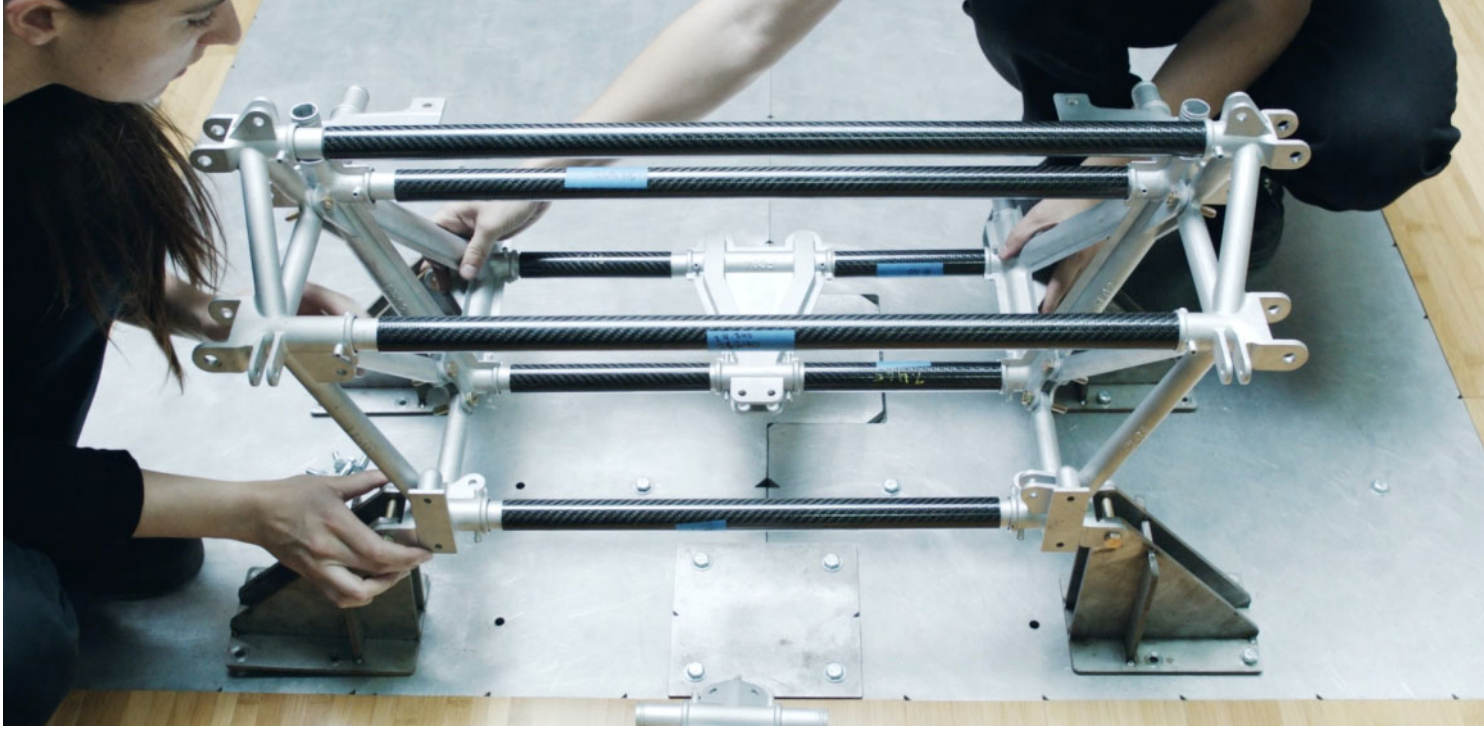
Transfer of Technology

Development of a local ecosystem for high-value components demands transfer and acquisition of technology from the global manufacturing ecosystems (or 'motherships'). Enhanced foreign direct investment (FDI) by global companies can facilitate organised supply chain development. Attracting FDI from the US in high-value components such as PCBs and semiconductors is critical, as these components are building blocks of

Figure 2: India's Exports of Smartphones



Note: Values are Inflation-adjusted; Source: Export Import Data Bank, Directorate General of Foreign Trade, Ministry of Commerce and Industry.



smartphones and many other advanced electronics products. In fact, PCB assemblies constitute approximately 40-50 percent of the value of an average smartphone, with critical sub-components like semiconductors constituting 25-35 percent of the value.[6,7] In any case, international trade rules prohibit India from employing a tariff-led approach India towards localisation of semiconductor manufacturing.[8]

In 2015, American companies accounted for approximately 50 percent of global semiconductor sales.[9] American companies are leaders in multicomponent semiconductors, a type of semiconductor widely used in smartphones, tablets, etc. With the world's largest fabless semiconductor companies such as Broadcom, Qualcomm, NVIDIA and Advanced Micro Devices, the US is well-suited to partner with India in setting up pure-play foundries or fabrication plants, thus facilitating technology transfer. The India-US ICT Working Group can be leveraged to initiate meaningful discussions towards this.

Absorption of Technology

Technology absorption is contingent on education, knowledge, skills, experience and training – and the US can play a significant role in facilitating each of these. For instance, Indian universities can partner with American universities specialising in semiconductor technologies and microprocessor development (such as The University of Texas at Austin, Texas State University). Such collaborations will help India in the adoption of best practices in crucial areas like curriculum design, teaching resource development, and benchmarking of occupational and skill standards. Additionally, American universities and companies specialising in advanced semiconductor technologies (such as wafer processing, laser technologies, etc.) can encourage student/employee exchanges and provide internships and apprenticeship opportunities.

Incubation of Technology

Realisation of value in smartphone manufacturing demands incubation of technology. Investment in R&D is crucial for this. However, India fares poorly in R&D activities. Gross R&D expenditure (i.e. public and private) as a percentage of GDP is only 0.6 percent – significantly low when compared to the US.[10]

India must leverage bilateral relations towards enhancing R&D focus. The governments of both countries can establish an R&D fund that supports research-related partnerships between government,

> “The US can play a vital role in accelerating India’s transition into an innovation hub at every associated stage of supply chain development”

academia and industry, by awarding grants for co-developing innovative products/processes in semiconductor and PCB technologies, amongst others. Existing R&D collaborations such as the US-India Science & Technology Endowment Fund (USISTEF) can be leveraged.[11]

The USISTEF is currently limited to biomedical sciences, ICT-linked research aimed at reducing the digital divide in areas like agriculture, energy, etc. Deliberations can be initiated on expanding its scope.

An R&D collaboration agreement establishing strong intellectual property right frameworks (including ownership, licencing to third parties, etc.) and other necessary provisions to conduct collaborative R&D may accelerate research-based cooperation. For instance, International Semiconductor Manufacturing Technology, which is a US-based research consortium of semiconductor companies, could co-develop cutting edge semiconductor technologies with India’s Centres of Excellence in Nanoelectronics under MeitY.[12,13]

Finally, a dedicated US-India research forum for discovering opportunities for research collaboration in smartphone and related components can be established. By organising joint exhibitions, seminars and workshops, such a forum can serve as a networking platform for connecting research communities. Existing forums like the Indo US Science and Technology Forum (IUSSTF) could also be leveraged towards this.

Conclusion

Building manufacturing capacity for high-value electronics components in India necessitates the adoption of an innovation-based lens through which R&D is encouraged and incentivised. Engaging with the US in research, technology transfer and manufacturing of high-value components such as semiconductors and PCBs offers such an opportunity for India. This involves not only passive cooperation wherein India can draw on the US’s experience, but also active engagement towards transfer, absorption and incubation of technology. Given that the US is already a major strategic partner, a deeper innovation partnership is much warranted.

Further, amidst global trade tensions, an India-US partnership in electronics manufacturing presents a strategic opportunity for the US. In July 2019, Japan imposed restrictions on the export of three chemicals/materials to the South Korea (photoresists, hydrogen fluoride and fluorinated polyimides), all of which are widely used by South Korean semiconductor industry.[14]

Export restrictions imply that Japanese exporters have to obtain licenses to export these chemicals/materials to South Korea. Japan has also removed South Korea from its ‘white list’ of favoured trade partners.[15] Moreover, in 2019, the US placed five Chinese firms engaged in supercomputing with military-related applications in its ‘entity list’, citing national security concerns.[16] Reasons for such flux include a mismatch in political and economic values between countries. These are not constraints within the India-US bilateral.

Endnotes

1 Ministry of Electronics and Information Technology (2019). National Policy on Electronics 2019. Available at: https://meity.gov.in/writereaddata/files/eGazette_Notification_NPE%202019_dated%2025022019.pdf

2 Ministry of Finance (2015). Union Budget 2015-16. Available at: https://www.indiabudget.gov.in/budget2015-2016/ub2015-16/bs/bs.pdf and Ministry of Electronics and Information Technology (2017). Phased Manufacturing Programme to promote indigenous manufacturing of Cellular Mobile Handsets, its sub-assemblies and parts/sub-parts/inputs of the sub-assemblies thereof. Available at: https://meity.gov.in/writereaddata/files/Notification_PMP_Cellular%20Mobile%20Handsets_28.04.2017.pdf

3 Pathak, T., Chatterjee, C., & Shah, N. (2016). Maximizing Local Value Addition in Indian Mobile Phone Manufacturing: A Practical Phased Approach. *IIM Bangalore Research Paper, (528)*.

4 Ministry of Electronics and Information Technology (2017). Phased Manufacturing Programme to promote indigenous manufacturing of Cellular Mobile Handsets, its sub-assemblies and parts/sub-parts/inputs of the sub-assemblies thereof. Available at: https://meity.gov.in/writereaddata/files/Notification_PMP_Cellular%20Mobile%20Handsets_28.04.2017.pdf

5 The Harmonised System (HS) codes for smartphones and various smartphones-related components are mapped using Custom Notifications (various years), Finance Act (2018) and PMP Notification.

6 Pathak, T., Chatterjee, C., & Shah, N. (2016). Maximizing Local Value Addition in Indian Mobile Phone Manufacturing: A Practical Phased Approach. *IIM Bangalore Research Paper, (528)*.

7 S. Ronendra, Singh (2013). Semiconductor units will leapfrog India's manufacturing capabilities. The Hindu Business Line. Available at: https://www.thehindubusinessline.com/info-tech/semiconductor-units-will-leapfrog-indias-manufacturing-capabilities/article20660314.ece

8 Components like semiconductors are covered under the Informational Technology Agreement (ITA-1) to which India is a signatory.

9 Platzer, M. D., & Sargent, J. F. (2016). US semiconductor manufacturing: Industry trends, global competition, Federal Policy. *New York: Congressional Research Service*.

10 World Development Indicator 2015

11 Administered by the Indo-U.S. Science and Technology Forum, an autonomous bilateral organization jointly funded by India and US, USISTEF supports R&D related collaborative initiatives between stakeholders in the two countries.

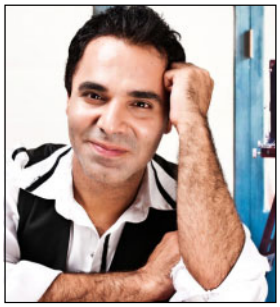
12 To combat competition from Japanese semiconductor manufacturers in 1980s, Semiconductor Manufacturing Technology (SEMATECH), an industry research consortium funded by the US government was formed in 1987. In 1995, the first wave of globalisation of SEMATECH was witnessed wherein international members were permitted to collaborate with consortium's 300 mm wafer technology and this led to the formation of International SEMATECH. However, in 1999, the SEMATECH restructured as an active 'global' consortium cooperating with European and Asian companies on all of its programs including interconnect technologies such as copper and low-k dielectrics, and front-end wafer processing R&D.EE Times (1999). Sematech restructures as a global consortium. Available at:
https://www.eetimes.com/document.asp?doc_id=1187881

13 MeitY Website. 'Nanotechnology Initiative Division under R&D in Electronics'. Available at:
https://meity.gov.in/content/nanotechnology-initiative-division

14 Lee, Yen Nee (23 July, 2019). The Japan-South Korea conflict could push up the price of your next smartphone. Here's how. *CNBC*. Available at: https://www.cnbc.com/2019/07/23/japan-south-korea-dispute-impact-on-semiconductor-supply-chain-prices.html

15 CNBC (August 1, 2019). Japan to remove South Korea from 'white list' of favored trade partners. Available at: https://www.cnbc.com/2019/08/02/japan-south-korea-trade-fight-tokyo-to-remove-seoul-from-white-list.html

16 Business Today (June 22, 2019). US blacklists five Chinese firms working in supercomputing. Available at: https://www.businesstoday.in/current/world/us-blacklists-five-chinese-firms-working-in-supercomputing/story/358183.html



Manoj Kewalramani
Research Fellow,
The Takshashila Institution

Ecosystem of Innovation Needed to Boost AI in India

AI advancement will deepen the permeation of technology in daily lives, requiring new perspectives on education, employment, social organisation, ethics and law.

A number of countries around the world have devised strategies to harness the economic potential of Artificial Intelligence (AI) while mitigating its risks. Studies tell us that AI could potentially deliver an additional economic output of around US$13tn by 2030.[1] For India, it is estimated that AI could add US$1tn to the economy by 2035.[2] Beyond GDP growth, AI advancement will deepen the permeation of technology in daily lives, requiring new perspectives on education, employment, social organisation, ethics and law.

Given such stakes, it is important for India to adopt a strategic approach towards the advancement of AI. Early steps in framing such an approach can be traced back to August 2017, with the formation of an AI task force led by the Ministry of Commerce and Industry.

The task force's report described AI as a 'game-changer' that was to be a "key factor in economic development" in the future.[3] It studied the potential impact of AI across 10 specific domains identified as relevant to India. These were examined from the point of view of the role of government, the potential of technology to solve problems and improve quality of life and impact on employment generation and growth. Finally, it made a set of six broad recommendations.

The task force's report was followed by a Niti Aayog discussion paper in June 2018, which outlined the pathway for a potential Indian AI strategy.[4] Niti Aayog described its approach as #AIforAll, which it says "implies inclusive technology leadership, where the full potential of AI is realised in pursuance of the country's unique needs and aspirations." The report identified five sectors that can benefit the most from AI in solving societal needs and outlined the barriers that need to be addressed in order to reap the benefits of AI in India.

Both these documents did well to identify the core constituents of AI development, i.e., investing in technological advancement, support for research and enterprises, skilling and talent development and the need to effectively leverage data. However, seizing the opportunities that AI offers requires decision-makers to devise a comprehensive

approach. This entails crafting policies across a range of areas, such as incentives to boost R&D spending, devising AI-specific education, legislation on data protection, ownership and access and enhancing IPR protection and judicial capacity, all of which feed into advancing an ecosystem of innovation.

The rest of this article examines five major policy areas where immediate attention is warranted.

Enhancing R&D Investment

Although there has been an increase in absolute terms, as a percentage of GDP, India's spending on research and development has remained at around 0.7 percent over the past few years.[5] This is among the lowest when compared with BRICS countries and far from the desired goal of two percent of GDP by 2022, as outlined by the Economic Advisory Council to the Prime Minister.[6] In addition, the Indian government has not allocated an AI-specific research budget. Allocation for AI research is clubbed with other sectors, such as robotics, IoT and quantum communications, under the broader Digital India umbrella.[7] Moreover, the private sector's contribution to R&D expenditure in the country remains rather low and has been declining.[8]

While public R&D spending is critical, it is also important to incentivise the private sector to spend more. Doing this requires a two-pronged approach. First, governments must ease the cost burden on enterprises via targeted tax breaks along with the creation of special zones or sandboxes. With regard to the former, there have been some steps taken over the past few years, such as tax deductions on expenditure incurred in approved in-house R&D facilities and the introduction of a 10 percent tax rate on income from worldwide exploitation of patents developed and registered in India.[9]

> “it is important for India to adopt a strategic approach towards the advancement of AI”

However, as analysts have pointed out, the eligibility rules to avail tax deductions are quite restrictive and neither does it incentivise transfer of existing foreign IP to India.[10] The latter refers to establishing sector-specific zones where trials and testing are permitted in a controlled environment, somewhat akin to pilot zones established in Chinese cities and provinces.[11] In this context, the RBI's regulatory sandbox for fin-tech sector is a step in the right direction.[12] Second, it is important to shift away from protectionist approaches, such as price controls in the drug and medical devices sector, and upgrade IPR regulation and enhance IP protection for innovations. Failure to do so will only diminish the incentive to innovate.

AI-Specific Institutions & Planning

The February 2019 interim budget speech by the Indian finance minister saw the government committing to the establishment of a national centre for artificial intelligence as a hub, along with other centres of excellence.[13] This was

largely in line with one of the recommendations of the AI task force, which had called for the establishment of an Inter-Ministerial National Artificial Intelligence Mission. N-AIM will be the nodal agency building synergies between academia, industry and government. It will also support AI-focussed centers of excellence and coordinate projects of national importance. What remains unclear is whether this center will operate independently, given that the government also wants Niti Aayog to direct AI research and development efforts.

Multiple planning and coordinating agencies are likely to divide resources and cultivate bureaucratic interest silos. Already, there are rumblings of a turf war between Niti Aayog and the Ministry of Electronics and Information Technology.[14] Further, while the Indian government has said that it is working towards establishing a national AI hub, there has been no movement on the recommended budgetary allocation. The AI task force had recommended that N-AIM should enjoy an allocation Rs. 1200 crore (approx US$171mn) over a period of five years. The Indian government, however, has not announced any specific allocation.

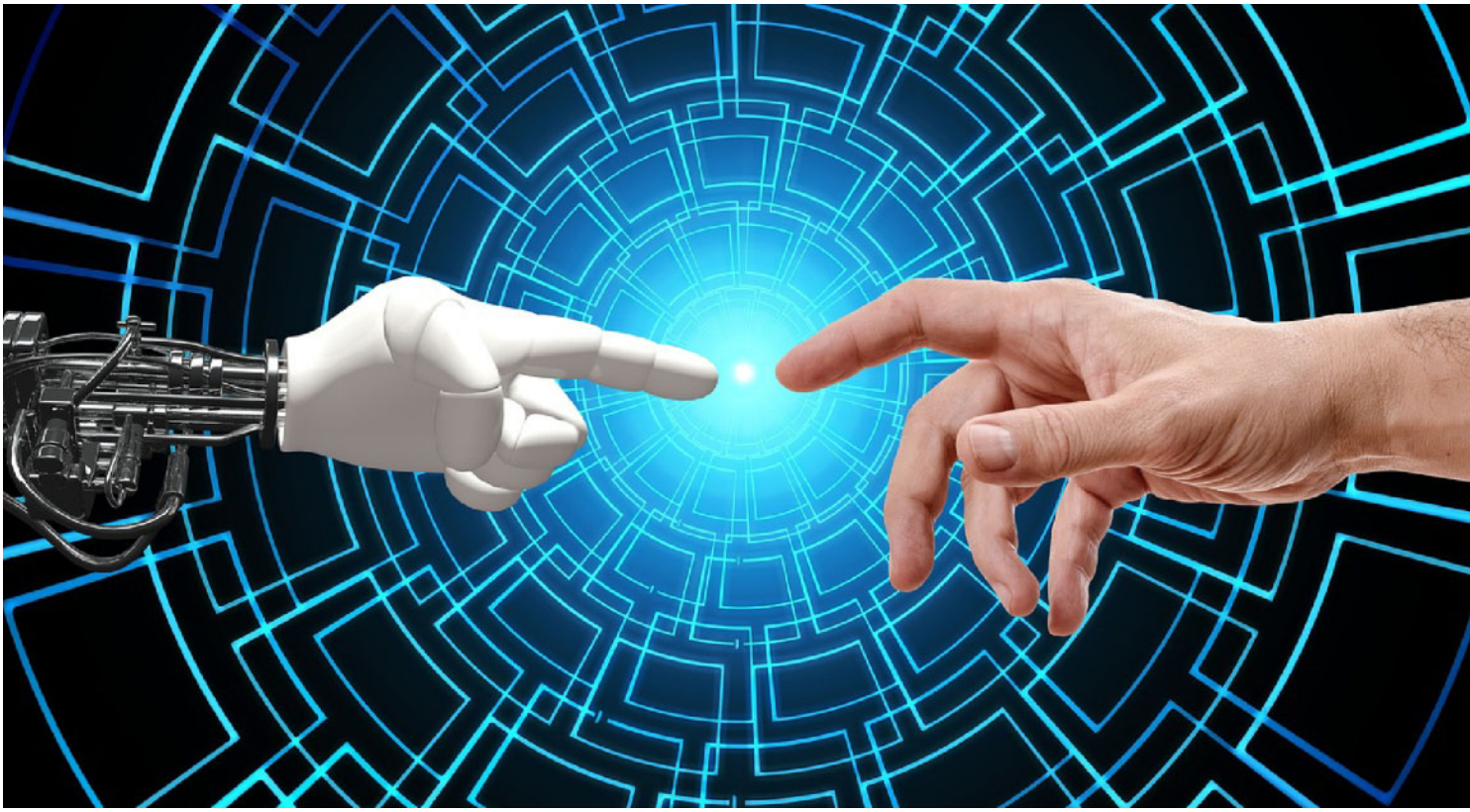
Education & Talent

During her July 2019 budget speech, Indian Finance Minister Nirmala Sitharaman promised that the government will "lay focus on new-age skills like Artificial Intelligence (AI), Internet of Things, Big Data, 3D Printing, Virtual Reality and Robotics."[15] That's an important statement of intent, but specifics remain sketchy. Talent is one of the key components of a strong AI ecosystem. This entails a range of individuals, from those conducting core research, those building products and finally downstream talent. Factoring this holistic perspective in the country's education policy is critical.

The draft National Education Policy appears to echo some of this. It states that "a robust ecosystem of research is perhaps more important than ever with the rapid changes occurring in the world today," citing machine learning and AI as critical to future development.[16] For starters, in terms of skilling the future workforce, the policy calls for India to take the lead "in preparing professionals in cutting-edge areas...such as artificial intelligence."[17] Although the specifics are sketchy, doing this is critical, given the potential for AI-related industries to support job growth. This is evident in the expansion of the data labelling and annotation industry in India.[18] Greater focus on specialised short-term courses that foster skill development in specific sectors would further aid such industries.

On the other hand, in the context of research in AI, the policy proposes a three-pronged approach that the National Research Foundation should adopt with regard to disruptive technologies like AI.[19] This is important, given that India lags behind key competitors in terms of the number of researchers, publications and patents.[20] In fact, a recently concluded study notes that India is home to merely 50 to 75 principal AI/ML researchers.[21] In order to expand fundamental research in the country, the study recommends an increased investment, attracting high-quality faculty and introducing undergraduate students to AI/ML courses. This echoes one of the recommendations of the AI task force, which called for devising AI-related curriculums and AI education strategy.[22]

What would further facilitate this is opening up the Indian education sector to foreign universities and capital.[23] Legislation to this effect has failed to materialise despite over a decade of debate.[24] Second, there needs to be a greater focus on school and university incubators. The Atal Innovation Mission through which tinkering labs and innovation centres are



being established is a step in the right direction.[25] Progress, however, has been slow. As of March 2019, out of the selected 5441 Atal Tinkering Labs, which are being established in schools, only 2171 received the first tranche of grants.[26] The corresponding number for Atal Incubation Centres, focussed on universities and industry, was 31 out of 101.[27] The key to the success of AIM is a consistent and timely investment, focussing on scale and outcomes through industry support. Finally, it is important to build industry-academia connections and re-examine metrics of qualifications in the context of skills shortage evident among Indian STEM talent.[28]

Leveraging Data

Data lies at the heart of AI development. It is the fuel that will drive future algorithms. However, the key lies in developing quality data sets from the complex mess of information produced and captured and effective labeling. Building India-specific data sets that are open access can power future innovation. Fortunately, there has been some progress in this direction. India's Open Government Data Platform already provides access to a range of data collected by various ministries. In addition, NITI Aayog's strategy proposed a national marketplace focusing on data collection and aggregation, data annotation and deployable models.[29] Since then, it has issued a request for proposal to establish the National Data and Analytics Platform (NDAP) through public-private partnership.[30]

NDAP will serve as a single point for accessing data across all ministries that is available in the public domain, providing open Indian data sets for researchers and companies. Some of the key areas where attention is already being directed are language processing, transport, weather, healthcare and agriculture. However, in order to effectively leverage data, it is critical that legislation addressing key ethical issues of ownership, copyright, privacy, consent, storage, access and protection is fast-tracked. Such issues lie at the heart of any AI strategy. In addition, it is important that regulations also provide frameworks for accessing private sector data while protecting users and the company's IP.

“It is important that Indian policymakers devise laws, regulations and policies that nurture the foundations of an innovative society and economy”

Judicial & Regulatory Environment

India jumped eight places to take the 36th spot in the 2018 Global Intellectual Property Index. The US Chamber of Commerce's Global Innovation Policy Center's index ranks the top 50 countries.[31] WIPO's rankings for 2019 also saw India reach closer to breaking into the top 50 innovative economies.[32] This is a recognition of a series of steps taken in the last few years to improve the regulatory environment. In 2016, a new National Intellectual Property Rights Policy was published.[33] The changes it envisaged are aimed at boosting innovation and entrepreneurship. In order to do so, IPR laws are being reassessed and strengthened. There is an effort to push for IP commercialisation. There is a push to reduce the time taken from the trademark assessment down to one month.[34] These are positive trends to promote broader innovation, which would support AI development.

But what is also needed is a greater focus on judicial capacity when it comes to IPR protection cases along with addressing the structural problem of pendency.[35] At present in India, the Intellectual Property Appellate Board is the specialised tribunal for select intellectual property disputes. Select IP disputes, however, do find their way to the High Courts. One pathway to enhance judicial capacity in terms of IPR protection and dispute resolution could be either establishing specialised IP courts, akin to the kind of system being established in China.[36] Some analysts have also suggested the possibility of establishing specialised IP benches in High Courts in India.[37]

The above underscores what constitutes a holistic approach towards developing an innovation ecosystem, which can power AI development. It is important that Indian policymakers devise laws, regulations and policies that nurture the foundations of an innovative society and economy. Specific steps need to be taken across a range of domains discussed above, beginning with AI-specific planning and budgetary allocations along with incentives to expand R&D investment. The cumulative effect of such enabling measures is likely to be greater commercialisation of scientific research. Therein lies the key to a winning strategy.

Endnotes

1 Jacques Bughin, Jeongmin Seong, James Manyika, Michael Chui & Raoul Joshi. 'Notes from the AI frontier: Modeling the impact of AI on the world economy.' September 2018. McKinsey Global Institute.

2 Rekha Menon, Madhu Vazirani & Pradeep Roy. 'Rewire for Growth: Accelerating India's economic growth with artificial intelligence.' 2017. Accenture.

3 Report of The Artificial Intelligence Task Force. DIPP, Ministry of Commerce and Industry, Government of India. March 2018.

4 National Strategy for Artificial intelligence. June 2018. Niti Aayog.

5 'R&D Spending In India Less Than China And Brazil: Education Ministry.' NDTV. July 22, 2019. https://www.ndtv.com/education/hrd-ministry-r-d-expenditure-in-india-less-than-china-and-brazil-2073497

6 'Growth in R&D expenditure to be targeted 2% of GDP by 2022: PM economic panel.' PTI. July 24, 2019 https://www.businesstoday.in/current/economy-politics/growth-in-rd-expenditure-to-be-targeted-2-of-gdp-by-2022-pm-economic-panel/story/367312.html

7 Rajesh Kurup. 'Govt doubles Digital India allocation to 3,073 crore; telecom sector disappointed.' The Hindu BusinessLine. February 1, 2018. https://www.thehindubusinessline.com/economy/budget/govt-doubles-digital-india-allocation-to-3073-crore-telecom-sector-disappointed/article22620283.ece

8 'India Inc's expenditure on R&D declines to lowest level in six years.' Business Standard. August 3, 2019. https://www.business-standard.com/article/companies/indian-companies-r-d-spend-declines-to-lowest-level-in-five-years-119080202058_1.html

9 'Harnessing private sector investment in R&D.' FICCI report. April 2017. http://www.ficci.in/spdocument/20884/R&D-Industry-Report.pdf

10 Gaurav S. Ghosh. 'Incentivizing private sector R&D in India.' Livemint. November 26, 2018. https://www.livemint.com/Opinion/9cJ0w68CdgCkybtzZEKwpN/Opinion—Incentivizing-private-sector-RD-in-India.html

11 'China to build 20 new AI innovative development pilot zones.' Xinhua. September 06, 2019. http://www.xinhuanet.com/english/2019-09/06/c_138371122.htm

12 Neha Alawadhi & Romita Majumdar. 'RBI finalises regulatory sandbox framework for innovation in fintech firms.' Business Standard. August 27, 2019. https://www.business-standard.com/article/finance/rbi-finalises-regulatory-sandbox-framework-for-innovation-in-fintech-firms-119081400067_1.html

13 'Budget 2019: National Centre for Artificial Intelligence to come up soon.' Economic Times. February 01, 2019. https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/budget-2019-national-centre-for-artificial-intelligence-to-come-up-soon/articleshow/67788227.cms

14 Surabhi Agarwal & Yogima Seth. 'Niti Aayog, MeitY spar over Rs 7,000 crore AI mission.' The Economic Times. August 27, 2019. https://economictimes.indiatimes.com/news/politics-and-nation/niti-aayog-meity-spar-over-rs-7000-crore-ai-mission/articleshow/70851052.cms

15 'Speech of Nirmala Sitharaman Minister of Finance.' July 5, 2019 https://www.indiabudget.gov.in/doc/Budget_Speech.pdf

16 Draft National Education Policy 2019. Ministry of Human Resource Development. Accessible here: https://mhrd.gov.in/sites/upload_files/mhrd/files/Draft_NEP_2019_EN_Revised.pdf

17 ibid

18 Cade Metz. 'Small towns in India are powering the global race for artificial intelligence.' The New York Times. August 18, 2019. https://economictimes.indiatimes.com/tech/internet/small-towns-in-india-are-powering-the-global-race-for-artificial-intelligence/articleshow/70711704.cms

19 Draft National Education Policy 2019. Ministry of Human Resource Development.

20 http://www.prsindia.org/report-summaries/draft-national-education-policy-2019

21 'Landscape of Artificial Intelligence and Machine Learning in India.' Itihaasa Research and Digital. 2018. http://www.itihaasa.com/pdf/itihaasa_AI_Research_Report.pdf

22 Report of The Artificial Intelligence Task Force. DIPP, Ministry of Commerce and Industry, Government of India. March 2018.

23 The draft National Education Policy evisages establishing international research efforts using AI to address key sectoral issues. This would be aided by opening the Indian education sector to foreign institutions.

24 The Foreign Educational (Regulations of Entry and Operations) Bill was first proposed in 2010. There has been some indication that the current Indian leadership would like to revisit the bill. But there hasn't been any tangible movement forward. More details on the legislation can be found here: 'Legislative Brief: The Foreign Educational Institutions (Regulation of Entry and Operations) Bill, 2010.' PRS Legislative Research. https://www.prsindia.org/uploads/media/Foreign%20Educational%20Institutions%20Regulation/Legislative%20Brief%20-%20Foreign%20Education%20Bill.pdf

25 'NITI Aayog's AIM has selected 3,000 additional schools for the establishment of Atal Tinkering Labs.' Economic Times. June 12, 2018. https://economictimes.indiatimes.com/news/politics-and-nation/niti-aayogs-aim-has-selected-3000-additional-schools-for-the-establishment-of-atal-tinkering-labs/articleshow/64555619.cms?from=mdr

26 Cabinet approves Continuation of Atal Innovation Mission. https://pib.gov.in/newsite/PrintRelease.aspx?relid=189295

27 Ibid

28 'Shortage of talent in Indian STEM sector due to skill gaps: Indeed data.' Moneycontrol News. Feb 28, 2018. https://www.moneycontrol.com/news/business/economy/shortage-of-talent-in-indian-stem-sector-due-to-skill-gaps-indeed-data-2517955.html

29 National Strategy for Artificial intelligence. June 2018. Niti Aayog.

30 'Niti Aayog invites bids for development of National Data and Analytics Platform.' PTI. June 19, 2019. https://economictimes.indiatimes.com/news/economy/policy/niti-aayog-invites-bids-for-development-of-national-data-and-analytics-platform/articleshow/70298261.cms?from=mdr

31 'India jumps 8 places to 36th on International IP Index.' Economic Times. February 8, 2019. https://economictimes.indiatimes.com/news/economy/indicators/india-jumps-8-places-to-36th-on-international-ip-index/articleshow/67884700.cms?from=mdr

32 The Global Innovation Index, 2019. WIPO. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019-chapter1.pdf

33 Report of The Artificial Intelligence Task Force. DIPP, Ministry of Commerce and Industry, Government of India. March 2018.

34 'Intellectual Property Rights regime in India: Initiatives by the government.' DIPP, Ministry of Commerce and Industry. January 24, 2018. https://spicyip.com/wp-content/uploads/2018/01/IPR-Regime-In-India-Government-Initiatives.pdf

35 More information can be found at 'Pendency of cases in the Judiciary.' PRS Legislative Research. Accessible here: http://www.prsindia.org/policy/vital-stats/pendency-cases-judiciary

36 Justice Tao Kaiyuan. 'China's commitment to strengthening IP judicial protection and creating a bright future for IP rights.' WIPO Magazine. June 2019. Accessible here: https://www.wipo.int/wipo_magazine/en/2019/03/article_0004.html

37 Jacques de Werra. 'Specialised Intellectual Property Courts- Issues and Challenges.' CEIPI-ICTSD Publication. March 2016. Accessible here: http://www.ictsd.org/sites/default/files/research/Specialised%20Intellectual%20Property%20Courts%20-%20Issues%20and%20Challenges_0.pdf

Andrew Sheng
Distinguished Fellow of the Asia Global Institute, University of Hong Kong

As AI Makes Inroads, People, Companies and Nations Must Digitise or Watch their Prospects Die

Sheng says Industry 4.0 calls for an ecosystem of universities, employers and students collaborating to meet the challenge of a digitised economy.

When Amazon bought the online pharmacy Pillpack last week for around US$1bn, the stock market valuation of several large pharmacy retail chains fell by US$14bn. That is the power of clicks (online e-commerce companies) over bricks (and mortar) high street retailers.

The once-powerful GE being taken off the Dow Jones market index is an indication of how old-style manufacturing and distribution companies are being marked down on a daily basis, whereas tech companies are valued in stratospheric terms.

The old economy is facing massive creative destruction in the shift to the new economy led by the Internet of Things (everyday objects with the online capability and communicating with each other), which involves digitisation and then retailing.

Every line of business, including the business of government and social services, is being disrupted. Every individual, company or nation faces marginalisation without a good digital transformation story.

The conventional wisdom is that digitisation is good for the consumer but bad for jobs. When I am told that artificial intelligence can already tell from a picture of a human iris whether the person is male or female, and human ophthalmologists can't, I know almost all jobs are now under threat. Job insecurity across all fields explains the populist votes for change and sentiments against immigrants, foreigners and globalisation.

“In practice, all jobs need to be reviewed in the new digital world. And the biggest change would not involve things or people, but mindsets”

Governments are having a hard time coming up with the right policies to confront this massive job change, even within governments, where digitisation can cut hugely bloated bureaucracies.

In practice, all jobs need to be reviewed in the new digital world. And the biggest change wouldn't involve things or people, but mindsets.

Coping with the digital revolution is really about how you should transform your business and organising the production of both goods and services. Jack Ma of Alibaba and Jeff Bezos of Amazon are thriving because they understand this change and are making it happen.

Industry 3.0 – the current business model – is essentially linear and stability-oriented. When Henry Ford invented the assembly line for making cars, he basically made workers assemble products in linear succession, which was more efficient than craftsmen who built everything from scratch.

The linear assembly line quickly evolved into supply chains, whereby Toyota has a whole chain of subcontractors and component suppliers to enable the company to deliver cars. Apple doesn't even manufacture phones, but designs and markets them, leaving Foxconn and others to do much of the research and development of how to produce what Apple designers want that suits the consumer.

Amazon and Alibaba (the pioneers of Industry 4.0) are the architects of their own digital ecosystems, orchestrating manufacturing, distribution and retailing through digital channels, running on cloud computing that they own and operate. In short, they moved beyond linear production to dynamic multitasking.

The common complaint by employers is that the current education system is not producing graduates who can be useful in jobs straight away. All new and old economy employers have to spend considerable resources retraining and reskilling their new and present employees.

This is simply because the education system is still based on the linear assembly line process, whereby young people go through 15-20 years of sequential formal education from primary to university level, using curriculums that are obsolete by the time they graduate.

Universities are producing balance-sheet employees, assuming that their graduates will remain on the books of a company for life. As more companies move to flexible production, subcontracting jobs out and cutting their full-time employees, that university education model is obsolete. In the internet era, all fixed costs are becoming variable. Fixed jobs are disappearing fast. Anyway, people don't stay in the same company for too long.

To paraphrase Lord Acton, there are no permanent friends, permanent enemies or permanent jobs, only permanent interests.

Schools and universities also face the challenge of massive open online courses (MOOC) that are being offered by top universities and teachers, often for free. Who needs second- or third-tier universities staffed by professors teaching outdated content, when you can access knowledge and branding (from top universities) cheaper and faster?

This is why there is a growing market for short-term specialised courses run by market-based professionals that help companies re-skill employees. Employers also use AI to cut down hiring, because leading companies need fewer and smarter employees who can be retrained faster in real work experience.

The solution to the skilling and reskilling dilemma is an internship. The education

> “In the digital age, it is not the knowledge that is the problem, but how to acquire and apply the right knowledge that matters”

system should be re-geared towards becoming an ecosystem for continuous upgrading of skills, working together with all employers – government, business or civil society organisations.

Taxation and education-spending policies should be geared towards universities as pools of cheap labour for employers, that provide interns real-life job skills in exchange for the opportunity to select and retain talent. In other words, university degrees should allocate up to half of the students' time for an internship. The tax and education subsidy system should be tailored to allow universities, employers and students to be mutually interdependent to produce better employees for the Industry 4.0 age.

To some extent, this is already happening, as many interns in Silicon Valley and elsewhere drop out of university and join their employers in start-up ventures, preferring on-the-job challenges, rather than learning more theory from textbooks. Teachers themselves would benefit from internships with companies, just as highly skilled workers would benefit from interchanging jobs to become professors (or teachers) of practice.

In the digital age, it is not the knowledge that is the problem, but how to acquire and apply the right knowledge that matters.

But the first step to conquering the digital divide is to change not just one's own mindset, but that of decision-makers at all levels. As the saying goes, those who know, can't decide, and those who decide, don't know.

And if you don't decide and then move on, you become marginal.

The article first appeared in South China Morning Post on July 06, 2018

Sector-specific Dimensions of Innovation

Building Agristack for the Benefit of Indian Farmers

Hemendra Mathur
Venture Partner
Bharat Innovations Fund

The digitisation needs building a platform to enable access to millions of farmers, which can be a source of accurate and real-time information that can be stored, used, shared and analysed – to the benefit of farmers.

Introduction

Indian agriculture needs digitisation to make supply chain efficient, transparent, market-driven and traceable. Digital technology can play an important role in enabling access of high-quality inputs to farmers, farmers' linkages to the market, reduction in post-harvest losses, enabling access of institutional credit, insurance and direct benefit transfer to farmers.

Farmers will benefit through improved farm economics with improved yield, reduced cost of inputs and ability to de-risk against commodity price fluctuations and monsoon failures. Consumers will also benefit with improved access to safe, nutritious and affordable food. Industry and government will also gain with access to reliable, timely and accurate data for decision making.

The digitisation needs building a platform to enable access to millions of farmers (85 percent of them being small and marginal), which can be source of accurate and real-time information that can be stored, used, shared and analysed – to the benefit of farmers.

AGRISTACK: A public digital platform to enable access to farmers

AGRISTACK – is conceptualised as a public digital platform for ready and almost instant access to farmers. This platform can be the hotbed for driving disruptive innovations in the agricultural sector. I will propose an architecture involving three essential building blocks as a starting point for building India AgriStack including: farmerStack, farmStack and cropStack.

FarmerStack: This is used essentially to identify the farmer whom we want to reach out. The data can be derived from JAM trinity. JAM refers to the government of India initiative started with an objective to plug the leakages of government subsidies. "J" stands for Jan Dhan, which is the bank

account number. "A" is for Aadhaar, which is the unique identity number given by the government. "M" is for mobile number. There is a good chance that farmer will have at least one the above, which can establish his identity.

FarmStack: This would include the location and dimensions of farm size. This is important to estimate farming needs and the income potential from the farm. This data exists in parts as few states in India have progressed with digitisation of farmland area. The records available with local governing bodies like panchayats could be one source for this data. The GPS coordinates (longitude and latitude) of the farm can be further validated with satellite imagery. Farmer and Farm stacks combined establishes who the farmer is, where is he located, what is his input needs and how much he can potentially earn from his farm.

CropStack: This would include data on the number of crops and type of crops, which farmer is growing. Data about cropping pattern is integral to potential interventions needed to improve farm economics. For example, the needs of a farmer growing vegetables is very different from one growing paddy. This data can also be captured through records available with local government bodies, nearest market yards and use of technology including satellite imagery and drones.

How can AgriStack Solve Problems of Indian Agriculture?

There are several possible application areas of Agristack. Some of them are:

Credit to farmers: Agristack can be used by banks and MFIs to assess creditworthiness of farmers and then tailor-make products for each one of them. As per the priority sector norms, 18 percent of Average Net Bank Credit (ANBC) for lending to agriculture. Total Agriculture Credit Disbursement during the year 2017-18 was Rs 11.68 lakh crores. Banks ability to reach out to farmers, judge their credit-worthiness and monitor crops for the purpose of recovery can be facilitated by Agristack.

Crop Insurance: The number of farmers (or farm holdings) covered under the Prime Minister's Fasal Bima Yojna (PMFBY) is about 47.9 million in 2017-18 (declined from a high of 57.5 million the year before). Majority of the farmers who availed crop insurance are the ones who have taken loan from banks (33 million). Only 30 percent of the gross cropped area is covered under insurance. Agristack can improve the access of crop insurance to wider farmer bases (non-loanee farmers in particular) and help bring more crop area under coverage. It can also help Insurance companies to understand farmer and farm risk profile, which is needed in deciding the premium and settling the claims.

Direct benefit transfer (DBT): The government can use Agristack for designing and implementing schemes for farmer welfare as well as for implementing "direct benefit transfer". The budgetary allocation for the food subsidy for FY 2018-19 is set at Rs 1.7 trillion. The fertiliser subsidy allocation for the budget year is set at Rs 700 billion. Thus, targeted food and fertiliser subsidy for the current FY stands at Rs 2.4 trillion. Given government's intent to move to DBT, Agristack can play a catalytic role in this process. Agristack can also be used for implementation of many farmer welfare schemes announced from time to time.

Market Linkages: Corporates selling or buying from farmers can also benefit immensely with direct and targeted access to farmers. The digitisation will help improve farmers' access to quality inputs to farmers and their ability to connect directly with multiple buyers, which can improve their price realisation.

Operationalising AgriStack

One can question why will farmer share this data. The answer is that the farmer will share data as long as he benefits from doing this. This platform can help farmers reduce the cost of inputs, find buyers and enable their access to finance, market and insurance in an efficient way.

If a farmer is concerned about data privacy and integrity, a consent layer on the lines of IndiaStack can be created where a farmer can share the information by giving permission selectively.

The question is who and how one can build AgriStack? My guess is, it has to be a collaborative effort including governments (both federal and state) along with industry and innovators. Use of technology in developing Agristack can optimise time and cost involved. There is clearly one-time investment in building this and then there will be recurring cost to maintain and continuously update it. This is worth the effort for the quantum of benefits this platform can offer.

Farmers can also be incentivised to share the data. For example, the direct benefit transfer scheme can make it mandatory for farmers to share data. They can share it directly or through local government bodies or any government-designated person in the village. The data can be selectively audited or compliance tools can be built to check and maintain the quality of data.

The basic Agristack can lead to the development of multiple applications. Some of them are discussed in the following section.

Building Data Layers and Applications on Agristack

A logical progression of Agristack would be the creation of unidimensional and multi-dimensional digital maps specific to agriculture. Agriculture-specific weather maps have already proven their utility. Likewise, it is important to map other parameters, which are paramount to farm

economics. The creation of these digital tools superimposed on Agristack can further drive many disruptions in the value chain.

Though there are multiple such maps needed, if I have to put my finger on the first four to be created, it will be – water stress map, soil nutrition map, crop time series (sowing to harvest) map, mandi map and consumption map. Let me touch upon each of these in more detail on why they are needed and possible ways to build these maps.

Water stress map

India is among the most water-stressed countries in the world. As per the study from World Research Institute, 54 percent of India is water-stressed (average per capita availability of water per year in India is about 1,540 m3). A recent report by NABARD points to the fact that agriculture productivity in India should be measured in terms of per litre of water rather than per hectare of land as water is scarce and depleting commodity as compared to land.

> “The development of Agristack and digital maps as public goods can be a game changer for agricultural supply chain”

Over and above, the frequency of droughts is increasing and over 40 percent of cultivable land lies in drought-prone areas. Excessive use of groundwater for irrigation has left many aquifers dry. The spatial distribution of monsoon has also becoming erratic (for example floods in Kerala and deficit rainfall in northeast region in monsoon months this year).

It is time to start building a repository of groundwater and surface water used specifically for the purpose of agriculture and monitor it on a real-time basis. Satellite imagery can be used to measure and monitor water availability both below as well as above the surface. The overlap of water maps on Agristack can help assess the water and irrigation requirement at a granular level (farm field, village or taluka).

These maps can be used as a guide to decide on cropping patterns in the water-stressed and water-rich areas. For example, water-intensive crops such as paddy and sugarcane need to be substituted with water-efficient crops such as millets in the high-water stress zones. Given more than 70 percent of available water being used for agriculture, we should be thinking to start tracking the “water balance sheet” for the purpose of agriculture so that water usage remains proportionate to available water assets.

Soil nutrition map

The current ratio of key nutrients — nitrogen, phosphorus and potassium (N:P:K) in Indian soil is 6.7:2.4:1 against the recommended ratio of 4:2:1. The ratio is much more distorted in states like Punjab and Haryana where N:P:K use ratios stand at approximately 31:8:1 and 28:6:1 respectively. The higher skew towards Nitrogen in most states in India can be attributed to higher subsidy on “N” as compared to “P” and “K” (Urea – key source of “N” - is out of nutrient-based scheme of fertiliser subsidy, which makes N relatively

cheaper to P and K). Such ratios are recipe for disaster, which is going to push down soil productivity.

Given the significant variation in NPK ratio as well as other critical nutrients (such as Sulphur, Boron, Zinc, Iron, Copper, Manganese), it is important to map their availability in soil. The government's farmers' portal is a good attempt to capture the nutritional profile of soil by district. It also captures pH values to measure acidity and alkalinity in soil; in addition to the nutrients.

The logical progression is to make the soil nutrition data more granular, real-time and actionable; ideally specific to farm by superimposing it on Agristack. One of the options is to start digitising soil health cards. The soil health card (SHC) scheme launched by the government in 2015, is an excellent government initiative to measure and report soil nutrition. About 107 mn SHC were dispatched in cycle I (2015-17) and about 50 mn have been dispatched till date in cycle II (2017-19). The digitisation of SHC and linking it to geo-tagged farms can make data more precise, granular and real-time. The use of technology such as hand-held soil scanners developed by likes of Soilcares can also cut short time and effort in measuring and reporting of soil data.

The soil nutrition map can help farmers in deciding fertiliser application rate customised to the nutrition deficiency in their respective farms. The fertilisers companies will also be big beneficiaries as this data will help in developing custom-made products and identifying the right target geographies. The availability of such data can also play a big role in designing the fertiliser-specific policies of the country.

Crop-time series map

Farmer selection of the crop is usually driven by last year's prices of commodities, which usually lead to glut/deficit situations and non-remunerative prices. The "crop dashboards" depicting area under production at any given point of time can make crop selection more scientific. The crop dashboards can be displayed on state highways, village panchayat offices as well as sent to farmer mobile phones. Real-time access to "sowing to harvest data" for different crops in Rabi, Kharif and Zaid can address the demand-supply imbalance. The wide variations in prices in TOP crops (Tomato, Onion, Potato), is seen almost every year, which can be taken care of with farmers' access to this information.

The accuracy of the time-series data can be further improved by using satellite imagery and drone monitoring in addition to ground-truthing. The crop detection algorithms developed on the basis of imagery by many start-ups are improving by the day, which can over a period of time reduce the need for ground-truthing efforts.

The other aggregation/ validation points for developing time-series data on area and production under a given crop could be the agri-input dealers who on the basis of advance booking and sales of seeds can predict sowing intention of farmers.

Mandi map

The agricultural marketing in India is regulated by the Agricultural Produce Market Committee (APMC) Act enacted by the state governments. There are approximately 2,500 principal regulated markets and approximately 4,800 sub-market yards regulated by the respective APMCs in India. It is possible that some of them are not operational. So essentially, there are approximately 7,000 agricultural mandis under APMC Act, which needs to be geo-tagged along with arrival volumes and pricing details.

Though infrastructure at many of these *mandis* has not kept pace with the increasing arrivals, still village *mandis* continue to be key aggregation points for farm produce and account for the bulk of purchase from farmers. The arrival and pricing information across *mandis* on a real-time is

Digital economy cannot be made inclusive without integrating farmers into it and without democratising access of innovations to Indian farming community

of significant value to farmers in deciding on "where", "when" and "what" price to sell. A farmer-friendly mandi digital map can enable this decision making. Though Agmarknet provides some of these data points, it is important to make it easily accessible and interpretable by farmers.

Increasing farmer avenues to sell and ultimately her / his income is possible if she/he has the option to sell at multiple mandis, which may not necessarily be the nearest one. With improving road infrastructure and access to third-party logistics company, a farmer has much better access to mandis which may be located in other districts/states. In addition to the mandis, the location of warehouses and cold storages can also be mapped; which can give farmer options to store and transport farm produce in the most optimal way.

The *mandi* density analysis from such maps in the context of arrival volumes will also help policymakers in re-designing infrastructure available in existing *mandis* as well as developing a roadmap for the number and locations of new *mandis* required.

Conclusion

The development of Agristack and digital maps as public goods can be a game-changer for agricultural supply chain. The challenge is to make the data points and maps granular, accurate, real-time and user-friendly with the least possible cost through optimal utilisation of technology and resources.

Given the importance of the sector, this is a good investment in the future for making the supply chain more efficient and transparent. In addition to stand-alone maps, multi-dimensional analysis of above digital maps (such as mandi density x production, soil nutrition x crop type) can be very insightful to all the supply chain members and policymakers in particular. There is a huge possibility of designing a host of innovations and applications on top of Agristack by start-ups ecosystem in agritech as well as consumer-tech.

Agristack and its various applications can catapult the much-needed digitisation of Indian agriculture to pave way for data-enabled supply chain - for the benefit of farmers, consumers and policymakers.

To conclude, the digital economy cannot be made inclusive without integrating farmers into it and without democratising access of innovations to Indian farming community. Farmers have been either ignored or underestimated on their ability and intent to use of digital tools. In my experience, they are ready to embrace it and a platform like AgriStack can catalyse the integration of farm and digital economy, which is much needed for Indian agriculture to leapfrog into a new era.

The article first appeared in yourstory.com on December 06, 2017

The Right Ways to Take US-India Energy Cooperation to the Next Level

Kartikeya Singh

Senior Associate (Non-resident), Energy Security and Climate Change Program and Wadhwani Chair in US-India Policy Studies

A renewed focus on energy can be leveraged to build strategic partnerships for both countries in the Indo-Pacific region.

Few people know of the breadth of energy cooperation between the United States and India. Historically, this cooperation spanned initiatives supported by various government agencies and covered a wide spectrum of sectors from fossil fuels to zero-carbon technologies. In fact, energy cooperation is considered one of the bright spots in US-India relations. Both sides recognise that an energy secure India is of interest to not only for India's development needs but is a necessary part of the US's vision for a free and open Indo-Pacific. Over the last two years, my team and I at CSIS have been busy identifying stakeholders who can deepen energy cooperation between the two nations. Now on the eve of the US-India "Two Plus Two" Dialogue between the senior-most officials from the two countries' foreign affairs and defence departments, I outline some recommendations for how to strategically bolster US-India energy relations.

Facilitate State-to-State Energy Cooperation

The US and India are both collections of powerful states. States are the laboratories of innovation: from the design of new policies and programs to testing and deploying new technologies. The sharing of these ideas and experiences of deploying emergent technologies can facilitate new avenues of cooperation in energy policy and commerce between states that share similar energy resources and interests. Just last year, the State Department's Bureau of Energy Resources supported CSIS and its India-based partner, the Shakti Sustainable Energy Foundation, to organise the first-ever sub-national energy workshop between the two countries to discuss how states in both countries are facing the challenge of managing the grid of the future. Insights from these conversations, which can lay the groundwork for building productive

subnational partnerships, need to get feed into the bilateral dialogue run by New Delhi and Washington, D.C. Doing so, perhaps through a recognised forum, would truly deepen energy cooperation between the two countries.

Create New Task Forces Open to Private Sector and Research Institutions

The government-to-government dialogue on the energy between the two countries used to be closed to the private sector and had limited participation from those research institutions that were funded by India's Ministry of Science & Technology and the US Department of Energy. Yet the role of these two stakeholder groups will be critical to creating, testing, and commercialising new technologies. As the two countries chart out ways for the greater private sector and research institution cooperation to manage their energy transitions, new focused task forces should be created that allow for public-private partnerships to form along the lines of what policymakers identify as priority areas. These task forces could focus on the following technology areas:

> "Energy cooperation is considered one of the bright spots in US-India relations"

Power & Energy Efficiency: Both countries are undergoing an energy transition that includes an influx of electricity from renewable sources, management of stressed thermal power assets, the rise of distributed generation, and the strong focus on demand-side management measures. New technological solutions, new business models, and learning from pilots in both countries can be shared to achieve their collective energy security goals while managing the emergence of this new energy system.

Electric Mobility: All 50 US states are creating plans for an electric mobility future under the Electrify America project while India's states are experimenting with the deployment of electric buses and transitioning their government-owned automotive fleets to all-electric by 2030. Lessons are being learned on both sides about the creation of charging infrastructure, setting up payment mechanisms and charging tariffs, and how best to support growth in manufacturing in this sector. Having strong automotive industries in both countries makes them natural allies to collectively focus on this opportunity.

Standards, Regulations & Security: Strategic energy cooperation between the two countries can truly be unlocked if stakeholders are developing and operating energy systems that function with similar sets of rules. The two sides should consider regularly convening key stakeholders from the US Federal Energy Regulatory Commission with India's Central Electricity Regulatory Commission, the American National Standards Institute with the Bureau of Indian Standards, and those focused on cybersecurity for the respective countries' energy sectors. This can bolster bidirectional commercial opportunities and collectively improve the energy security of both nations.

Joint Research and Development: In 2009, both countries co-created truly unique joint research and development (R&D) programme to fund basic research in key

technology areas. Both countries are also members of the Mission Innovation Initiative. The US clearly has an upper hand being armed with a well-established and well-resourced network of energy laboratories spread across the country focusing on different types of technologies. At the recently concluded conference of power and renewable energy ministers of India's states convened by the government of India, it was announced that the country is considering the establishment of a national mission on R&D. A focused task force on what this might look like between the two countries would bolster the energy R&D capabilities of a major US ally.

Strengthen Bilateral Energy Education, Entrepreneurship, and Skills Cooperation

Finally, ensuring job security, especially when faced with the prospects of greater automation in manufacturing, is a major concern for both countries. Endowed with abundant resources and human capital, the dynamic energy sector presents an opportunity for both countries to leverage to ensure that they are able to create new types of jobs. Building on the recently concluded Global Entrepreneurship Summit (part of a series started by the US and recently hosted by India), the two sides should create a strategy to connect US and Indian institutions that are focused on energy education, entrepreneurship, and skills development for the emergence of new energy technologies. This process might uncover ways that can add value to each other's manufacturing supply chain and possibly marry "Made in the USA" and "Make in India" a priority of ruling political parties in both countries.

India as a Strategic Energy Partner

Energy security is a key pillar to further a nation's development agenda and fuel its economic growth. As a long-standing area of cooperation between the two nations, a renewed focus on energy can not only strengthen ties between the two nations but be leveraged to build strategic partnerships for both countries in the Indo-Pacific region. For example, India has extended lines of credit and technical assistance for the development of critical energy infrastructure in many parts of Asia and Africa. Meanwhile, the US recently announced the Asia EDGE Initiative, which seeks to promote energy security and expand energy access in addition to working jointly with Japan on critical infrastructure projects in third-party countries. Aligning these strategies will take the US-India energy partnership to the next level and help realise the shared vision for the Indo-Pacific for both countries.

The article first appeared in The Diplomat on September 03, 2018

Natasha Jha Bhaskar
General Manager,
Newland Global Group,
Australia

Infrastructure & Innovation Partnership for a Sustainable Future

Advances in technology are creating new avenues for optimising productivity and understanding consumer demand and preferences.

Governments today face the challenge of ensuring fiscal consolidation while fostering growth, competitiveness and employment. Hence, there is a strong demand for efficiency, better governance, faster delivery and more user involvement. But the question is what does it take to deliver and fulfill the rising aspirations? What does it take to address changing needs and improve quality and accessibility for all? The answer, in most cases, is innovation. Innovation becomes imperative when problems are getting worse, when systems are not working or when institutions reflect past rather than present problems with outdated solutions. As the great Victorian historian Lord Macauley wrote: 'There is constant improvement precisely because there is constant discontent'.

Global demand for high-value, highly skilled and customised services and new technology is accelerating. Advances in technology – including the way we generate, process and use data – are creating new avenues for optimising productivity and understanding consumer demand and preferences. The future prosperity, health and sustainability of the world are closely bound to the human capacity for innovation.

The Infrastructure Challenge

The most tangible evidence of a nation's progress is its infrastructure sector. Basic infrastructure like roads, information and communication technologies, sanitation, electrical power and water remains scarce in many developing countries. An estimated 3.8 billion people still do not have access to the Internet, representing 80 per cent of the population in the least developed countries. Three billion people worldwide lack access to basic sanitation and three in 10 people lack access to safely managed drinking water.

If one looks at the UN's Sustainable Development Goals, infrastructure and innovation are a singular goal. Investments in infrastructure – transport, irrigation, energy and information and communication

technology – are crucial to achieving sustainable development and empowering communities in many countries. It has long been recognised that growth in productivity and incomes, and improvements in health and education outcomes require investment in infrastructure and innovation.

Economic growth, social development and climate action are heavily dependent on investments in infrastructure, sustainable industrial development and technological progress. In the face of a rapidly changing global economic landscape and increasing inequalities, sustained growth must include industrialisation that first of all, makes opportunities accessible to all people, and two, is supported by innovation and resilient infrastructure.

India's Infrastructure Sector

As India emerges as the world's leading economies, a key factor obstructing its growth and development is the lack of world-class infrastructure. Estimates suggest that this lack of adequate infrastructure reduces India's GDP growth by 1-2 percent every year. Fast growth of the Indian economy in recent years has placed increasing stress on physical infrastructure, such as electricity, railways, roads, ports, airports, irrigation, water supply, and sanitation systems, all of which already suffer from a substantial deficit. Even though we have been building infrastructure, we are not able to keep pace with demand. That results in huge productivity losses.

India will require investments of over US$4.5tn by 2040 for the development of its infrastructure to operate and thrive. The goals of inclusive growth and 9 per cent growth in GDP can be achieved only if India's infrastructure deficit is overcome. Infrastructure development will also help create a better investment climate in India. There are many issues that need to be addressed in different infrastructural fields. To begin with, the gap between electricity production and demand is affecting both manufacturing and overall growth.

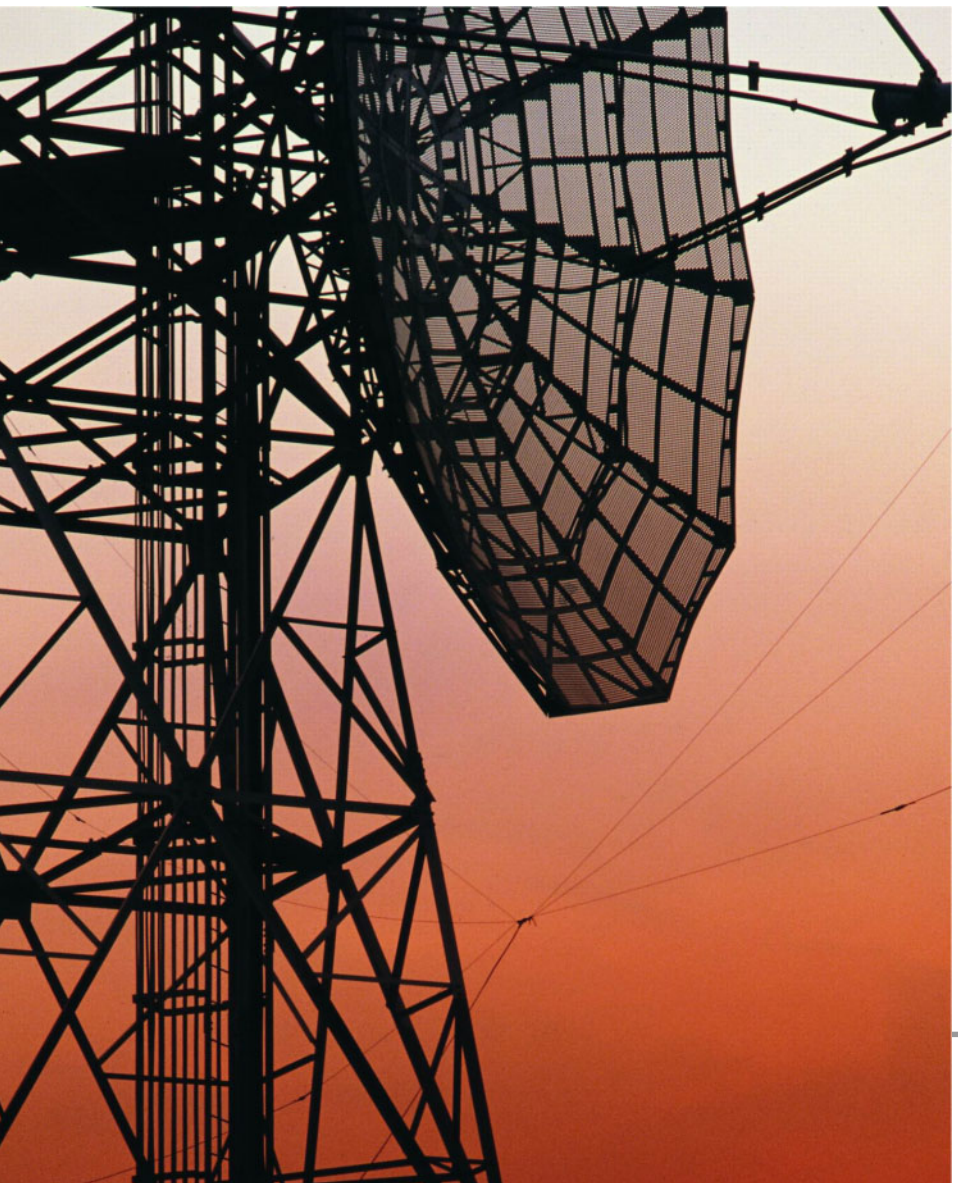
Another concern is the transport sector; while road transport is the backbone of the Indian transport infrastructure, it is inadequate in terms of quality, quantity, and connectivity. Furthermore, civil aviation and ports desperately need modernisation. It is expected that the public sector will continue to play an important role in building transport infrastructure. However, the resources needed are much larger than what the public sector can provide. To develop infrastructure in the country, the government needs to review issues of budgetary allocation, tariff policy, fiscal incentives, private sector participation, and public private partnerships (PPPs), and address issues of limited outlay, money invested poorly, bureaucratic bottlenecks, lack of innovation.

> “Advances in technology are creating new avenues for optimising productivity and understanding consumer demand and preferences”

Innovation in Infrastructure Development

The new, rising India, which wishes to fulfill the aspirations of its citizens, needs a strong infrastructure to facilitate sustainable development. Hence, innovation in infrastructure development has to be understood across three dimensions, which are an innovation in government policies, innovation in technologies and innovation in financing.

Government policies may not always be conducive enough for infrastructure development. They may be too focused on the short-term, not well coordinated and constrained by too much rigidity. It is essential to develop a sound infrastructure development plan — one that serves current and future user needs, drives improved economic growth, and minimises socio-economic disparities. But doing so requires translating bold ideas into feasible projects that are politically durable and adaptable when dynamics change, and involves stakeholders across spectrum.



The second area is technological innovation. The world has seen a surge in new technologies that have transformed many industries in the last decade. Infrastructure can also benefit from some of these technological advancements, at the design and planning stage, which could be utilised for better planning and better forecast of costs and time required for infrastructure development.

The third area is financial innovation. Infrastructure remains underfunded and this will not become easier in today's climate of austerity. How developed countries like the US and Australia can play their role, in India's growth story?

Financing Indian Infrastructure

The Indian infrastructure story is witnessing an agonising paradox. On one hand, India needs to create fresh capacity in its infrastructure to maintain the growth momentum. On the other hand, the banks, which have been the main source of funds for infrastructure projects, are saddled with mounting levels of stressed assets, which have almost choked their ability to lend. And incidentally, the infrastructure sector accounts for a major chunk of that stressed assets portfolio. Several of the projects are no longer viable due to time and cost overruns.

Hence, it is crucial to develop innovative financing approaches. For far too long, India has depended mostly on bank finance for infrastructure projects. Such dependence has always caused asset-liability mismatches. It is high time we start exploring other long-term funds, both foreign and domestic. There

are numerous Pension Funds (PFs) in the developed nations, which are on the lookout for attractive investment propositions. The PFs, with a large pool of long-term funds, will be the perfect fit for infrastructure projects. Collaborating with governments, development finance institutions, and the private sector may be considered as a few of the priorities with regard to financing.

The US-India-Australia Infrastructure Investment Partnership Opportunity

Capital is the key to advancing India's infrastructure sector. India will require investments of over US$4.5tn by 2040 for the development of its infrastructure. Of this, India will be able to meet about US$3.9tn, leaving a US$526bn deficit. A key goal of India's suite of regulatory reforms is to attract more foreign investment into the sector, including through new investment vehicles and innovative financial instruments by 2030. India's quasi-sovereign National Investment and Infrastructure Fund is establishing itself as one of the main channels of investment into Indian infrastructure.

Most recently, AustralianSuper, Australia's largest superannuation fund, and Ontario Teachers' Pension Plan, Canada's largest single profession pension plan, decided to invest US$1bn each with the National Investment and Infrastructure Fund (NIIF) Master Fund. The Fund invests in equity capital in core infrastructure sectors in India with a focus on transportation, energy and urban infrastructure; the significant investments demonstrate the international interest in Indian infrastructure and reconfirm the many strengths of the new innovative infrastructure financing vehicles for global capital.

Investment in the Indian infrastructure sector provides a diversified asset class and geography for investors in the US and Australia, especially for those seeking higher returns than those available in more developed markets. Economies like the US and Australia are dependent on new sources of growth. Hence, an opportunity exists for India to form regional collaboration, with like-minded countries where the primary purpose is to co-develop innovation as well as investment capacity in the infrastructure sector, which can provide further impetus to India's economic diplomacy. India can seek to pair Australian specialised capabilities in transport systems, water and waste management with the US's concessional finance capacity to deliver large projects in India.

India can learn from Australian expertise in infrastructure financing including value capture and user charges, in issuing municipal bonds or green bonds, in 'Toll-Operate-Transfer' and 'Build-Operate-Transfer' models, asset recycling and privatisation experiences.

> "The new, rising India, which wishes to fulfill the aspirations of its citizens, needs a strong infrastructure to facilitate sustainable development"

Conclusion

Power, water, communications and transport – all are essential parts of modern existence. These services facilitate the quality of our lives. They connect people in ways that create security and stability.

We have already seen how highways turned around the US economy and how Australia has one of the world's most developed logistics networks. India's fundamental strengths include its very large domestic market, young and growing population, a critical mass of educated people with strong science and engineering capabilities. India is a world centre for many digital services, a location where "anything that can be off-shored" can be done very cost-effectively. India today is seeking to accelerate the transfer of scientific knowledge from universities, laboratories, and individuals into the marketplace, which can offer solutions to its pressing problems. "In this process, we must learn from each other".

The changing geopolitics, the expansion of global markets, the information and communications technological revolution, and India's recent economic growth and economic openness can surely be the foundations of a growing US-India-Australia trilateral infrastructure innovation partnership, creating a network of institutions in the public and private sectors, whose activities and interactions initiate, develop, modify, and commercialise new technologies and promote greater investments in the sector for a sustainable future.

Gopala Krishnan
Co-Founder, WayBeyond Media Pvt Ltd

A Collaboration Model to Accelerate High Quality Healthcare for the World

The US and India have been unable to leverage their complementary strengths in mass healthcare technology effectively.

Collaboration between healthcare innovators in the US and healthcare organisations in India is now possible at a massive scale, and there are distinct ways to make it happen. This collaboration can significantly accelerate the approvals and commercialisation of promising technologies and therapies.

The example of Google collaborating with Shankar Netralaya is merely one of the famous early examples. What we can do and must do is to expand the scope and scale of such collaborations significantly. We have the opportunity to extend both testing and deployment, to a broad base of millions of patients in a short period.

The solution for this is one or more specialised accelerators that connect innovations and pre-FDA approval technologies from the US to medical academies in India. The establishment of such an accelerator will result in tests on a ready base of millions of patients by deploying the technologies to hundreds of clinicians. The metrics will then be compiled and analysed in a non-partisan manner by the academies themselves.

This approach will result in rapid approvals and commercialisation in India. The commercial availability in India will happen even before the US FDA approvals.

Also, the India test results will help to speed up the US FDA approval process while dramatically reducing costs.

Collaboration - Technology has Created New Possibilities

The US and India have been unable to leverage their complementary strengths in mass healthcare technology effectively. This inability to harness the complementarities must change.

The issue so far was that drugs were the core mass healthcare technology. Collaboration for low-cost drug trials does not work because they often lead to allegations of abuse or exploitation. The

already FDA approved drugs have been a cause of market disputes rather than collaboration. Due to the conflict between the need to protect intellectual property and the need to deliver affordable medicines to low-income populations.

Thankfully, this does not have to be a problem that continues to exist, going forward. Large scale collaboration in healthcare can be an immediate reality.

The most rapidly growing, disruptive, emerging healthcare technologies are no longer drugs. They are diagnostic tests and personalised therapies. It is no longer about the discovery of drug molecules, but more about devices, sensors, imaging, computing, data sets and artificial intelligence.

Across genetic, bio-chemical or bio-mechanical areas, we are seeing the emergence of a host of technologies that will significantly empower the frontline medical practitioner to diagnose and treat better and faster.

> “Collaboration between healthcare innovators in the US and healthcare organisations in India can significantly accelerate the approvals and commercialisation of promising technologies and therapies”

The Healthcare Technology Wave

A combination of technologies working together is rapidly going to disrupt the world of healthcare. These technologies will accelerate the availability of advanced diagnostics and personalised medicine at the point of care.

These include rapid innovation in the following areas, usually in combination-

- Internet-connected devices and sensors
- Core diagnostic technologies
- Artificial intelligence-driven diagnostics and personalised treatment

Thousands of innovative teams, in startups and within enterprises in the US are working on new technologies. These technologies are making new diagnostic and predictive capabilities available and are also changing the cost and form factor of these.

Capabilities that only large hospitals or labs could afford to have will be available as a result of these technologies, even in small clinics and with individual/ independent medical practitioners.

The innovators, however, struggle to bring their technologies to market because of costs of sample collection, trials and FDA approvals. Therefore, many promising technologies get discarded early, and the initiatives collapse.

The Academies in India

Medical associations in India work to enhance the opportunities and capabilities of their doctor members. They routinely conduct professional training for their members and channel research opportunities to them. The patient reach of some of these associations is extensive indeed.

For example, an association, such as the Federation of Obstetric and Gynaecological Societies of India (FOGSI) has well over 30,000 members. Each member is an ObGyn with a post-graduate qualification in Obstetrics or Gynaecology. Assuming an average of 20 appointments a day by a practicing ObGyn, we are looking at about 200 million patient consultations in a year by members of FOGSI.

FOGSI will surely be keen to enhance the diagnostic and therapeutic capabilities available to its members. It has the power of numbers to negotiate attractive offers for its members. Its members, in turn, benefit from new services capabilities, enhanced patient outcomes and increased clinic income by offering these services to their patients.

Associations like FOGSI can also help to fast track approvals and certifications of promising technologies within India.

The Value of Collaboration

For most diagnostics technologies, from the perspective of the doctor, the core value is the ability to diagnose early and start treatment as soon as possible. Pre-approval technologies accepted as an indicative test that enables the rapid start of treatment and which can be confirmed subsequently by a conventional investigation.

Deployment of pre-approval technology at a few hundred clinics is possible, with a patient base of a few million. There are several methods of ensuring active cooperation and participation of these clinics in these tests. There are also several ways to ensure that the costs of this can be a small fraction of what it would cost for much more modest scale trials in the US.

Besides, the Academy itself will conduct a non-partisan analysis of the results and publish it. The Academy also can make a representation to government and fast track certifications for India.

All this reduces costs and risks for many technologies that will otherwise fail to cross the clinical testing chasm of death. I estimate that over 95 percent of promising technologies fail at this stage, for want of capital to go through these test-fix-test cycles.

How will this Work?

The low cost accelerated testing makes it possible to finance the tests in two ways. The first is risk capital at angel or accelerator levels. The second is by equipment financing via existing schemes of cross border agencies like United States Agency for International Development (USAID), International Finance Corporation (IFC) and others.

A proven approach for this will be to set up a healthcare accelerator. The accelerator will be a platform with at least one major Academy participant, a couple of leading VC funds and deep linkages with institutions (USAID, IFC, ADB or others)

Promising technologies can score $50K to $0.5M of funding on this platform, specifically for the India test and commercial pilot.

Setup and Start

A couple of leading Academies in India are already keen to participate. End-to-end execution capabilities for conducting the extensive scale tests, analysis and certifications in India is also available.

The next step would be for a couple of VC funds to come in, to set up the accelerator. The institutional participation is not then a significant challenge.

Vikram Mahajan
Director, Aerospace and Defense, USISPF

Bilateral Cooperation for Innovation in Defence between US and India

India has become the world's third-largest start-up hub. There is no sector in India that has been untouched by innovation.

PM Modi while speaking at 'FII2019' stated that India has become the world's third-largest start-up hub. There is no sector in India that has been untouched by innovation. The exclusive domain of defence has recognised the strength and potential of innovation. Towards this, many government and non-government organisations, some in collaboration have started to promote start-ups in defence.

Defence Innovation Organisation

In April 2017, the Indian government launched the Defence Innovation Organisation (DIO) as a non-profit company, with a focus on technology development and product innovation with the potential for commercialisation in the defence sector. DIO has been formed with two founding industry partners — Bharat Electronics Limited and Hindustan Aeronautics Limited. It is also to foster a culture of engagement with innovative start-ups, to encourage co-creation for defence and space sectors. The governance of the DIO sits with the Defence Ministry with one nominated Director from each of the industry partners.

Innovations for Defence Excellence

Innovations for Defence Excellence (iDEX) will function as the executive arm of DIO, a programme started in April 2018 to equip the armed forces with cutting-edge technology by fostering start-ups. Under the iDEX scheme of the Union Government, more than 600 applications were received. 44 were finally shortlisted out of which seven are on AI for which government is ready to give financial support up to Rs 1.5 crore.

Defense Innovation Unit

The US has a similar organisation called Defense Innovation Unit (DIU, formerly DIUx). The 'Defense Innovation Unit – experimental' (DIUx) was created in 2015

by then-Secretary Carter to complement the Pentagon's existing defence Science and Technology (S&T) system of agencies with a new focus on 'innovation for the warfighter' – i.e. getting new technological solutions to the frontline military more quickly. Initially envisioned as a technological outpost in Silicon Valley and other ecosystems, the 'experiment' part was removed after the success of the organisation was well established. For DIUx, the critical areas of interest range from autonomy and AI to human systems, wider IT and space.

Due to the common field of interest and the growing strategic partnership between the US and India, various avenues to collaborate between the innovators of two countries have been established. The oldest of these is the India Innovation Growth Programme (IIGP).

India Innovation Growth Programme

India Innovation Growth Programme (IIGP) is a unique tripartite initiative of the Department of Science and Technology (DST), Government of India, Lockheed Martin and Tata Trusts. Launched in 2007, IIGP has been one of India's longest-standing public-private partnerships. The programme has provided mentoring and handholding assistance to over 400 innovators coming from diverse sectors from across the country; generated over 350 commercial agreements and over US$900mn of economic value for India. Supporting the Government of India's missions of "Start-up India" and "Make in India", IIGP 2.0 enhances the Indian innovation ecosystem by enabling innovators and entrepreneurs through the stages of ideation, innovation and

acceleration, to develop technology-based solutions for tomorrow.

During the announcement of the 2019 version of IIGP 2.0 Lockheed Martin also announced the establishment of Memorandums of Understanding (MoUs) with three Indian Start-ups. The MoUs pave the way for Terrero Mobility, Sastra Robotics, and NoPo Nanotechnologies, graduates of the IIGP, to integrate with Lockheed Martin's supply chain, and contribute to the evolution of both the Indian and global aerospace & defence industry. Through these agreements, LMCO will provide engineering support, mentoring, and assistance in the qualification of some of the technologies proposed, all of which contribute to the mission of making in India.

> "There is no simple 'one-size-fits-all' solution for defence innovation nor for all defence agencies"

Collaboration between iDEX and DIU

The collaboration between iDEX and DIU has been pondered over for a few years now. The proposal was first made in 2017 by the US to involve the Indian team ahead of the '2+2 dialogue', which involves the defence and foreign affairs ministries of the two nations. Since then, various defence delegations that have visited the US, and also DIU both, in Mountain View, California and in Boston to see the functioning of the organisations. Since then, India and the US have worked out the nuances that will enable defence teams to visit and collaborate in cutting-edge defence innovation unit in Silicon Valley. The unit identifies and funds emerging military technologies including artificial intelligence to space, robotics and information technology. Towards this, IDEX is starting work with the world-leading Stanford course on 'Hacking4Defence', to attract young engineering talent to defence innovation.

DTTI

The other avenue for collaboration between the innovators from both the US and India is the Defense Technology and Trade Initiative (DTTI), which started in 2012. DTTI is a flexible mechanism to ensure that senior leaders from both nations are persistently focused on the opportunities and challenges associated with growing our defense partnership. One of the aims is to transform the bilateral defense relationship into one that is limited only by independent strategic decisions, rather than bureaucratic obstacles or inefficient procedures. This is to be achieved by exploring new areas of technological collaboration from science and technology cooperation through co-development and co-production, and it includes start-ups.

Over the years, the DTTI has progressed and both the countries have been working on avenues that will exclusively be undertaken by innovators from both the countries. One of the projects that were decided in the last DTTI meeting to be undertaken by the start-ups from both sides is 'air-launched swarm drones.' These will be small UAVs that can be launched from

> “Collaboration is important in innovation, the way it has started between the US and India”

transport aircraft like C-130J and C-17. There are many more avenues that the start-ups under the umbrella of DTTI can undertake which will be decided in the future bilateral meetings.

Defence Offsets

The Defence Offsets are used to leverage capital acquisitions to develop the Indian defence industry by fostering the development of internationally-competitive enterprises, augmenting capacity for Research, Design and Development related to defence products and services. Under the provision of defence ‘offsets’, there is a proposal to invest in MoD registered professionally managed SEBI regulated fund. This fund will be dedicated to the development of start-ups and MSMEs of defence, aerospace and internal security-related enterprises in the country. The OEM contributing to the fund would be entitled to usual returns on its investment s per law. Considering that the largest offsets are discharged by US companies, this would be another avenue where the US OEMs will be contributing to the development of Indian start-ups, as and when this policy is implemented.

Conclusion

Innovation can mean many things to many people. Government actors in the innovation space play a range of roles: which is largely determined by the dynamics of each nation’s state ‘system’ of agencies, the wider ‘ecosystem’ in which they operate and their specific organisational mandate. Some agencies play more than one role at the same time, and many operate at different stages of the innovation lifecycle.

There is no simple ‘one-size-fits-all’ solution for defence innovation nor for all defence agencies. Various countries are experimenting with their established practices for defence innovation, by adapting the state’s formal ‘system’ or creating new agencies and missions within it to tap the wider ecosystem. Many, if not all have a significant number of different agencies and units whose collective role is to meet today’s defence innovation challenge: namely to build and maintain defence capabilities while recognising that that cannot be done simply through internal innovation activities. Therefore, collaboration is important in innovation, the way it has started between the US and India. Both countries have great minds which when put together can create avenues that have never been ventured into before. Such avenues help, not just in contributing to the economy, job creation and overall development of the nation, but also help in strengthening the bilateral ties between the countries.

Yusuf T Unjhawala
Editor, Indian Defence Forum

Towards Realising the Indo-US Defence Partnership Potential

India and the US conduct the largest number of military exercises with each other and the level of interoperability has increased over the years.

Indo-US strategic ties have grown significantly in the last 15 years. India has bought nearly US$18bn worth of defence equipment from the US - from transport jets and helicopters to surveillance planes to attack helicopters to howitzers. India and the US conduct the largest number of military exercises with each other and the level of interoperability has increased over the years. The signing of the logistics and communications agreement has helped the two countries advance their military relations further.

One area that the two countries have not made great progress is defence technology cooperation. India is the only major country that does not make all the advanced weapons it needs. It does not have a well developed military-industrial complex. India wants to change that and acquire advanced technologies. Over the years, it has had technology transfers built into its defence imports from its traditional supplier Russia, but that has not helped it in a big way due to lack of technology absorption capabilities and also withholding of crucial technology that countries guard and do not want to part with.

In 2012, India and the US initiated the Defence Trade and Technology Initiative for co-development and co-production of defence equipment. The US also set up a special desk to expedite any request from India. However, not much headway was made as it has not produced any highly visible product like the Indo-Russian Brahmos supersonic cruise missile or the Indo-Israeli Barak surface to air missile.

The US considers India as an important partner in the Indo-Pacific region. While India is not going to allow itself to be used by any other country to balance against a third country, there is convergence of interests in its security partnership with the US. It is in the interest of both countries to have better technical cooperation which will help interoperability.

The signing of the "Joint Statement of Intent" during the visit of the Under Secretary of Defense for Acquisition and Sustainment of the United States Ellen Lord to India in October 2019 on deliverables in

the short, medium and long term shows that lessons of the past have been learned and there is serious intent to move forward to co-develop and co-produce weapons systems. The choice of the products is very relevant for the Indian armed forces and look deliverable at the outset.

The near term projects which have been defined as ones that can take off in about 6 months are air-launch small unmanned aerial systems, lightweight small arms technology and intelligence, surveillance, target acquisition, and reconnaissance (ISTAR).

There are two mid-term projects which are maritime domain awareness solution and virtual augmented mixed reality for aircraft maintenance. And two long-term projects which are the terrain shaping obstacles and counter unmanned aerial system rocket artillery and mortar or CU-RAM. This involves developing highly accurate weapons systems to physically neutralise enemy drones or drone swarms. The latter is especially of importance to India as both Pakistan and China already have and are developing more drones. Pakistan has been using small drones to drop arms and ammunition into border areas of India. The drone attack on the Saudi oil facility which cut half of its oil production shows that drones can be used with devastating effect and there is no effective counter to it right now. Its availability to non-state actors puts vital installations along India's borders at risk.

However, issues still remain on technology sharing between India and the US although India was declared a 'major defence partner' and also given the strategic trade authorisation-1 (STA-1) status. Critical technology like jet engines that were under consideration was shelved as the US did not need any co-development of jet engines as it is a world leader in making jet engines. Its jet engine manufacturers will not part with some critical tech they have like single crystal blades that India needs. Lord on the

suspension of the programme said, "We could not come to an understanding of what exportable technology would be useful to the Indians. And we did run into a challenge in terms of the US export control."

India has to understand that the US military-industrial complex is in the private sector that is driven by profit. It will not share with India crucial tech that they have developed spending billions of dollars that give it the edge in weapons technologies. They will not help in creating competition for themselves by giving away critical technologies. So while the US government may be inclined to provide technology to India for strategic reasons, private US companies will part with it only if they see a business case.

India's close defence relations with Russia and the access that Russia has in India is a concern for the Americans who fear that their advanced technology could fall into Russian hands. The US has concerns about India acquiring the S-400 air defence systems which the US says can compromise the F-35 by giving critical input about the stealth fighter. Although the sale of the F-35 to India is not under consideration, it is said that India's acquisition of the S-400 closes that option.

Recently, a State Department official in response to the question on defence technology cooperation with India said "We don't want it to be exposed because some Russians walking the shop floor decide to go walk away and put it in their handbag or knapsack and take it back to Moscow". This clearly shows the apprehensions in the US about India's ability to control defence technologies. The cyber attacks on India's nuclear and space installations by the North Koreans to extract data shows India needs to tighten the security of its data. While it makes sense for India to have diverse options for weapons purchase, it restricts what it can extract from the US which is ready to work with India.

India has to work to tighten up control on defence technologies that convinces the US to share critical technologies. The US has on its part has to better appreciate India's historic reliance on Russia for weapons.

There is more opportunity for defence cooperation between India and the US. Setting up OEM production lines in India and developing local supply chain which will require amendments in the laws in India to allow 100 percent FDI. This will not only help create a defence ecosystem in India but also integrate Indian companies in the US supply chain. This could also be used to export to third countries. In fact, such an offer was made by the US with its F-16 whose production line it offered to shift to India for India's fighter jet acquisition and also for any export orders. India did not accept that offer and is now running another tender. But Lockheed Martin has got orders for nearly 100 F-16 blocks 70 since the offer was made. These could have been made in India and would have been a very visible

"India has to work to tighten up control on defence technologies that convinces the US to share critical technologies"

> The coming years hold a lot of promise for Indo-US relations

success of Indo-US defence cooperation. It was a missed opportunity.

There can be joint research and development and production between the US and Indian companies for both the Indian and export markets. With the security competition heating up in the Indo-Pacific, the defence requirement for the countries in the region is growing as these countries face the threat from China. It is in India's interests to fulfill the security needs of these countries to enhance its own influence. However, it is limited by its capabilities. For example, India sourced Mi-24 helicopters from Russia and Belarus to supply to the Afghan security forces. Similar requirements exist in Southeast Asia but it is possible that India which relies on Russian origin equipment, will be constrained to supply.

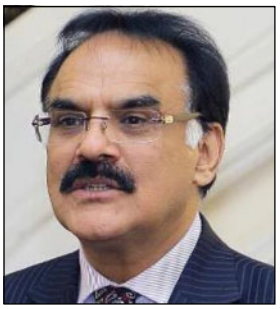
For example, the sale of the Brahmos supersonic cruise missile to Vietnam has been pending for years. Vietnam, which faces increased Chinese maritime aggression in the South China Sea, needs defence equipment. However, the Brahmos needs clearance from Russia which has grown increasingly close to China and relies on it economically. China can lean on Russia to stop any potential weapons transfer that threatens Chinese interests.

As Indo-US interests converge on China, it will be in India's interests to develop weapons systems with the US that can leverage its own large requirement to provide economies of scale and provide affordable weapons to the countries in the Indo-Pacific and beyond.

While Indian and the US armed forces exercise regularly, there should be an interaction between them on weapons systems development and they should be on board to develop qualitative requirements for joint R&D and production than just leave it to the bureaucrats and DRDO. This will ensure that projects undertaken are not something the armed forces of either country don't want or falls short of their requirements. This is what happened with the Raven UAV project under DTTI which the Indian Army did not find to its requirement. The DRDO has a history of coming up with projects that the armed forces do not need or suit their requirements. The Comptroller and Auditor General report of 2011 said that only 19 percent of DRDO projects went into production. So the involvement of the Indian Armed Forces for any Indo-US project is imperative to achieve good results.

The coming years hold a lot of promise for Indo-US relations. While there are apprehensions in the US on sharing technology and hesitancies of history in India that slows the pace of embracing the US as well as the pull of its decades of security ties with Russia, both sides know that close defence ties between them are important for regional and global security. The breaking of these barriers is a couple of visible deliverables away.

Time to Boost Innovation based Indo-US Energy Storage Cooperation



Arvind Mayaram
Chairman
CUTS Institute for Regulation & Competition and Former Finance Secretary Government of India

Garima Sodhi
Senior Fellow
CUTS Institute for Regulation & Competition

Rinki Singh
Former Associate Fellow
CUTS Institute for Regulation & Competition

There is a need to promote energy storage innovation, build human capital, infrastructure, and market mechanism, and to facilitate technology transfer between India and the US.

Introduction

The energy cooperation between India and the US has been a centerpiece in the bilateral relationship between the two countries for a decade now. Much has been discussed and implemented since May 2005 when the 'US-India Energy Dialogue' was first launched to enhance mutual energy security, promote increased energy trade and investment, and facilitate the deployment of clean energy technologies.[1] The two countries have strengthened their strategic partnership in the energy sector via subsequent collaborations to achieve shared goals of universal energy access, energy security, energy efficiency, low carbon emission, climatic change, etc. The most recent collaboration is the '**India-US Strategic Energy Partnership**' convened in April 2018.[2]

The countries through this partnership seek to facilitate the engagement of industry and stakeholders in the energy sector to enhance energy security, expand energy and innovation linkages across respective energy sectors. The partnership primarily focuses on four pillars of cooperation: (1) Oil and Gas; (2) Power and Energy Efficiency; (3) Renewable Energy and Sustainable Growth; and (4) Coal.[3]

It aims to create favorable policies and commercial investments in support of these goals. The objective of reduction in greenhouse gas (GHG) emissions provided a major impetus to transition to clean energy. In 2018, the US and India generated 17 percent[4] and 21.2 percent[5] of electricity via renewable resources respectively. India aims to install 175 GW of renewable energy capacity by 2022. This includes 100 GW from solar, 60 GW from wind, 10 GW from

> The two countries have strengthened their strategic partnership in the energy sector via subsequent collaborations to achieve shared goals of universal energy access, energy security, energy efficiency, low carbon emission, and climatic change

bio-power and 5 GW from small hydropower. Whereas, the US analysed through a study that with the present commercially available technologies with a more flexible electricity system, it will be able to produce 80 percent of its electricity through renewable energy in 2050 and deliberates to further the aim.[6]

Although the electricity generated from renewable resources is eco-friendly and can help in the reduction of greenhouse gases, the major problem associated with renewable energy is that it is highly intermittent. These variations in power generated from renewable resources need to be managed via an energy storage mechanism that can support the electricity grid to maintain its stability. The Electric Energy Storage System embraces diverse technologies with the ultimate aim to store it in the form of energy and later releasing it at the time of need. Hence the optimum utilisation of the unlimited source for energy generation by storing it in the form of energy is the need of the hour. This development at both ends provides a pool of opportunities for the US and India to strengthen their strategic collaboration under the current partnership. In this paper, the authors provide recommendations to bolster the strategic alliance in the energy sector between the two countries by focusing on innovation and deployment of Energy Storage Mechanisms by advancing collective funds and formulating policies for the cause.

Energy Storage in India and the US

Globally, countries are investing in research and development to make renewable energy more reliable and reduce intermittency. The US has emerged as the world's leader in lithium-ion storage batteries and has contributed to many incremental innovations in the energy storage sector.[7] Recently, the Department

of Public Utility (DPU) of Massachusetts has approved a plan that includes storage technologies like batteries and behind the meter (BTM) energy storage.[8]

The US came up with its first maiden large scale energy storage project in 1929 with the name of Rocky River Pumped Storage Plant.[9] However, the major development in the formulation of energy storage policies and technologies came in the 1970s after the United States' oil crises and since then, there have been several developments in policies and technology of energy storage in the country. Currently, the major available technology for energy storage is: Pumped Hydroelectric Storage (PHS), Compressed Air Energy Storage (CAES), Advanced Battery Energy Storage (ABES), Flywheel Energy Storage (FES).[10] The PHS approximately contributes around 94 percent of total energy storage equating to around 23.6 GW as of June 2018. The CAES technology for energy storage in the US is still at a nascent stage with only four operational plants contributing a combined rated power of 0.114 GW.[11] A significant movement in the integration of Artificial Intelligence (AI) with the energy storage technology to provide better grid stability and reliability has also begun.[12]

The US-based company 'Stem' has been providing the AI services for energy storage to businesses on a large scale. Recently, the state of Massachusetts has partnered with Stem to set up 28.2 MWh of the large energy storage project, co-located with the solar photovoltaic plant in the state.[13] India has also increased its endeavor for the development of lithium-ion storage batteries. It got its first MW scale grid-tied energy storage plant at Rohini in Delhi in February 2019.[14] India has decided to set up at least 4 tesla-style factories of 10 GWh to manufacture batteries to accomplish what tesla has done at its Gigafactory in Nevada, US.[15] The bids for 3.6 gigawatt-hours of

> The US has emerged as the world's leader in lithium-ion storage batteries and has contributed to many incremental innovations in the energy storage sector

storage connected to 1.2 gigawatts of solar on India's interstate transmission system have been called by the Solar Energy Corporation of India (SECI).[16]

A 2.6 GW of pumped storage capacity has also been established in Tamil Nadu at 400 MW.[17] The developments in energy storage in India is still at a nascent stage and requires government impetus. In that direction, on August 09, 2018, the draft National Energy Storage Mission (NESM) was proposed to aspire for leadership in the energy storage sector by encouraging manufacturing, deployment, innovation and further cost reduction in the sector. The mission recognises three key areas for energy storage application – integration of renewable energy with distribution and transmission grids; setting rural microgrids with diversified loads or stand-alone systems; and developing the Storage component of electric mobility plans.[18]

The government has already approved the National Mission on Transformative Mobility and Battery Storage to further the strategies for transformative mobility and Phased Manufacturing Programmes for Electric Vehicles (EV), EV Components and Batteries.[19] Apart from these initiatives for battery storage, India has recently amended its 'National Wind-Solar Hybrid Policy (NWSHP)'[20] to include storage of energy produced by wind-solar hybrid plants in the forms of battery, pumped hydro, compressed air, flywheel, etc.[21] This policy encourages new technologies, methods, and way-outs involving the combined operation of wind and solar PV plants.[22] These policies have tremendous potential for India and the US to collaborate and further the mandate of the Strategic Entergy Partnership.

India-US Energy Cooperation for Energy Storage

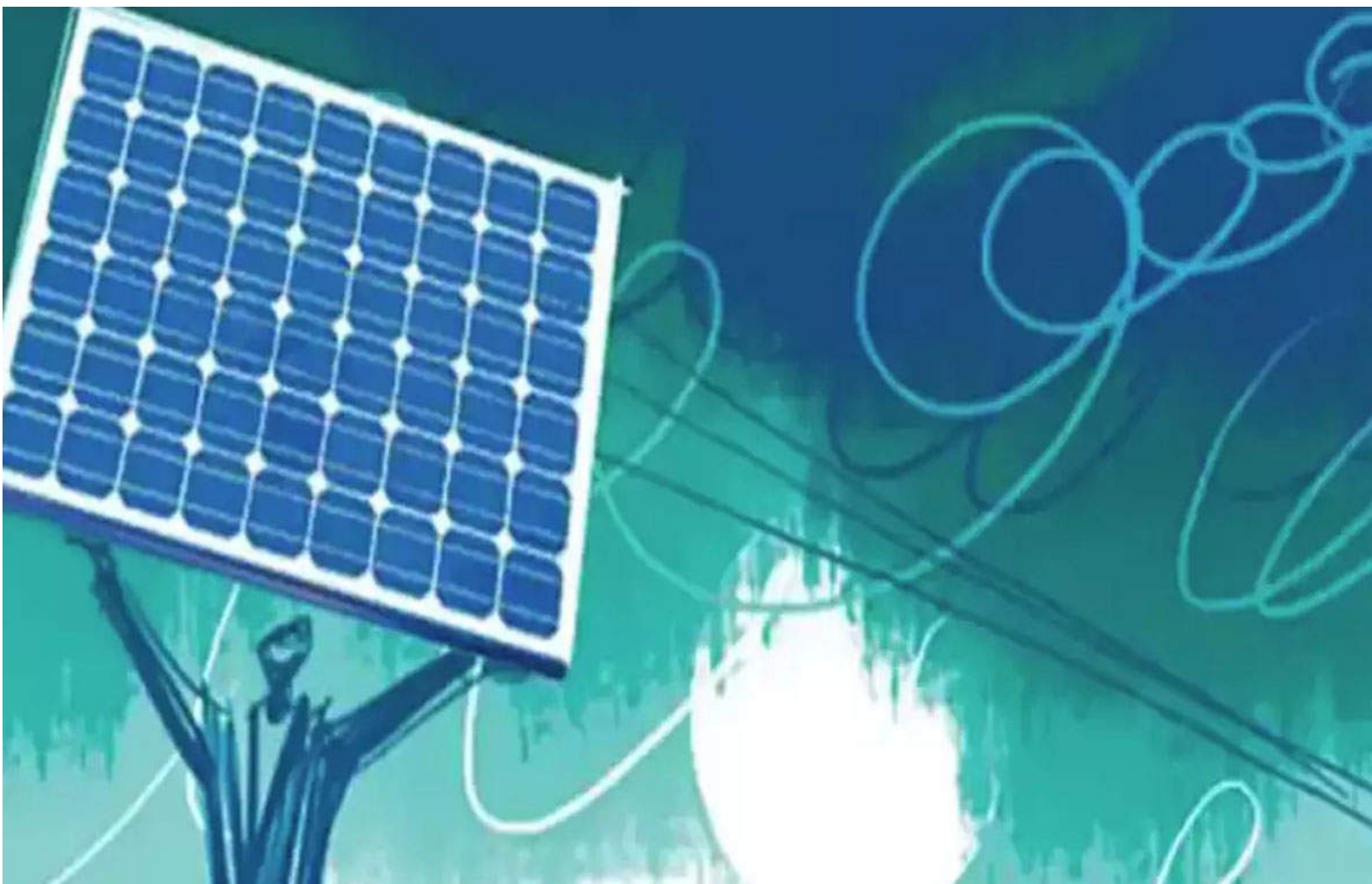
In 2009, India and the US entered into Partnership to Advance Clean Energy (PACE) as a flagship programme on clean energy[23] which was expanded in 2017 to research **'Smart Grids and Energy Storage'** as the second phase under the 'Indo-US Programme to Advance Smart Grid Technology, UI-ASSIST (US-India collaborative for smart distribution System with Storage)'.[24] The partnership was effected via two components: a research component, known as PACE-R, and a deployment component, known as PACE-D. Under PACE-R, the Indo-US Joint Clean Energy Research and Development Center (JCERDC) and the Solar Energy Research Institute for India and the US (SERIIUS) were established to promote clean energy innovation by teams of scientists and engineers from India and the US.[25] Whereas, PACE-D was designed to tackle multiple clean energy deployment opportunities. A PACE-D Technical Assistance (TA)

Programme was run by the US Agency for International Development (USAID) to support clean energy deployment assistance in India. PACE-D provided grants under the Development Innovation Ventures programme to stakeholders to build micro-grids and stand-alone systems in rural areas.

Currently, USAID, in collaboration with the Ministry of New and Renewable Energy (MNRE), is working on the market driven deployment of energy storage technologies. This collaboration could be upgraded to another phase to further the solar-wind hybrid projects and other energy storage methods under the present India-US Strategic Energy Partnership. The agreements under PACE umbrella concerning energy storage could also be expanded to further the goals and objectives of NES. Below are some recommendations in this regard:

1. Establishment of a Research Center for Joint Research on Energy Storage

In 2017, the scope of research under PACE-R at JCERDC was expanded to its second phase to research 'Smart Grids and Energy Storage'. It is recommended that India and US, may further expand the scope of research at JCERDC to its third phase to include research in the use of AI, Internet of things (IoT) in microgrids and energy storage, Pumped Hydroelectric Storage (PHS), Compressed Air Energy Storage (CAES), behind the meter (BTM) energy storage, Flywheels, etc. Alternatively, a new joint research center for energy storage could be established by the two countries. Further, skill training/knowledge sharing programs should also be conducted for Indian students and professionals to enhance understanding of the subject and further the research in this area.



2. Establishment of a Finance and Incubation Centre to support Startups focusing on Energy Storage

Under PACE-D, a Clean Energy Finance Center (CEFC) was also set up in the American centre at New Delhi to support the financing of clean technology.[26] The scope of this centre could be expanded from the solar power market to include assistance in the deployment of energy storage plants, PHS, CAES, etc. India and the US should also collaboratively establish an incubator exclusively for incubation of startups focusing on energy storage technology, to promote innovation and development in the energy storage sector.

3. Partnership at Sub-National Level

Under PACE-D TA, the USAID developed partnerships with states in India to strengthen the institutional framework and regulatory environment at the sub-national level. A partnership between the US agencies (like USAID) and states in India should also be encouraged to the enhance institutional capacities of the state nodal agencies and regulators to assist in strengthening the regulatory, planning and design process for accelerating the deployment of energy storage plants, stand-alone systems, microgrids, etc.

4. Tax incentives and subsidies

Policies like tax incentives, granting of land at discounted prices to the start-ups and subsidies to manufacturers would support the development of energy storage rapidly. The US legislators introduced the Energy Storage Tax Incentive and Deployment Act to establish investment tax credit (ITC) for businesses and home use of energy storage.[27] Denmark became the leader in generating energy through wind power by offering 40 percent of the initial capital investment and also granted tax incentives to consumers for generating power.[28]

China also adopted a similar strategy in 1999 and is now the world leader in solar manufacturing with around 70 percent of the total panels being manufactured in China. It did so by investing US$47bn over five years in the grant of loans, lands and tax incentives to industries setting up plants.[29] India would be required to follow similar policies for the rapid expansion of renewable energy and energy storage technology, and to attract larger investments.

5. Encouraging companies to invest in energy storage as a part of CSR

India took a bold step by becoming the only country in the world that mandate companies to do Corporate Social Responsibility (CSR) activities if the turnover of the company is more than 1000 crore (in US$bn pl) or are making a net profit of 5 crores annually to do a mandatory CSR up to two percent of their net profits for the welfare of the society. The CSR activities have seen substantial investment in the welfare schemes with a cumulative spending of a whopping Rs 50000 crore (in US$bn pl). in the past four years.[30] The recent trends show that the companies are majorly focused on spending CSR funds in two-sector i.e. education and health with total spending of 2,705.3 crore and 1144.83 crore respectively as per FY 2017-2018.[31] The government has to create awareness among big companies to spend CSR funds in the research and development of energy storage technologies in the county. The Government should encourage corporates to install stand-alone energy storage plants to store energy as a part of CSR spending so that they can consume the stored electricity and reduce GHG emissions.

6. Setting procurement targets

Procurement targets are a mandate prescribed by the State Legislation for

acquiring a specific amount of energy storage. It helps in promoting the usage of energy storage by giving support to investors and reduce regulatory uncertainty associated with the new technology.[32] The California Public Utilities Commission (CPUC) has come up with the procurement target policy that mandates utilities to procure 1325 MWe of energy storage by 2020 in the State.[33] Oregon followed the path of California and in 2015, and set up a target for large utilities for the procurement of at least 5MWh of energy storage by 2020.[34]

There are other states like New Jersey and others that have set procurement targets. However, it directed the state regulators to conduct a yearlong study for optimum utilisation of energy storage before implementing the targets. To promote the consumption of energy storage in the country, the government has to come up with a compulsory procurement scheme for the large scale industries. However, this suggestion cannot be implemented in India immediately due to a lack of infrastructure for energy storage in the country.

7. Policies for the integration of non-conventional resources including energy storage to the electricity generation

There is a need for more inclusive policies such as the generation of electricity from non- conventional resources as well. Recently, in the US, the Federal Energy Regulatory Commission (FERC) issued Order no. 841 that deals specifically with the integration of energy storage with the US wholesale energy market.[35] The order directed the regional grid operators to establish rules that open capacity, energy, and ancillary services markets to energy storage and affirmed that the storage resources must be compensated for all of the services provided and level the playing field for storage with other energy resources.[36]

Recently, NITI Ayog and Rocky Mountain Institute, United States jointly came up prepared a report on India's energy storage mission for manufacturing energy storage batteries in India. After that, the government came up with National Energy Storage Mission in 2018 and National Mission on Transformative Mobility and Battery Storage, 2019. However, in the present scenario, there are no such policies or laws for the integration of energy storage into the electricity grid. A joint study should be conducted by India and the US to explore the integration of energy storage with the power grids keeping the markets' operational differences and the socio-political condition of India in mind.

“A joint study should be conducted by India and the US to explore the integration of energy storage with the power grids keeping the markets' operational differences and the socio-political condition of India in mind”

8. Setting up of energy storage and renewable energy fund

Renewable energy technology is still a very costly affair and thus involves a huge risk. To promote the usage of renewable energy and energy storage, the government should launch a crowdfunding programme where everyone is allowed to participate and the centre should act as the custodian of that fund. At the end of every year, the centre should disclose the fund raised from each state and proportionately distribute those funds to them. Crowdfunding is widely used by countries such as the US, European Union, South Africa, etc. for generating funds, especially in the clean energy sector.[37]

However, their mode of crowdfunding is different because the company that is setting up a plant for renewable energy generates funds from the people through a regulated website where people can donate money online and the government does not have any role in it. Owing to the socio-economic condition of India, and lack of interest of industries in this particular sector, the Government should be directly and involved in encouraging crowdfunding to give confidence to the industries interested in investing in this specific field.

9. Establishing a council for collective partnership

The energy storage technology is at a nascent stage and is far from perfection. It requires extensive research and development especially for increasing the backup and life[38] to make it more reliable. Although various institutions are operating for furthering this, there is a need for a big and cooperative consortium with active participation by the government in granting funds, collaborating with various research institutions at the national level and also by inviting companies to be a part of it. A large scale collaboration for research and development has greater chances of success than research conducted through individual effort.[39]

10. Demonstration projects

The demonstration projects are the pilot projects that help the government as well as for the public at large to analyse the pros and cons of the energy storage programme on an incremental basis. In the United States, there are 15 demonstration projects funded by American Recovery and Reinvestment Act for that help the stakeholder to have a better and in-depth understanding for the development of energy storage projects and the stakeholders can also predict the risk attached to it and can be prepared for it in a much better way.[40]

Five other states in the US have their demonstration model with the latest project being implemented in Massachusetts by introducing Advancing Commonwealth Energy Storage (ACES) wherein the state granted US$20mn for testing various multi-usee business cases for energy storage.[41] A similar effort is required in India. Demonstration projects would help to promote energy storage in the country by alleviating the skepticism of companies for investment in such technologies.

Endnotes

1 https://mea.gov.in/Portal/ForeignRelation/India_US_brief.pdf

2 http://pib.nic.in/newsite/PrintRelease.aspx?relid=178727

3 *Ibid.*

4 https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

5 http://www.pib.nic.in/Pressreleaseshare.aspx?PRID=1555373

6 https://www.nrel.gov/docs/fy12osti/52409-4.pdf

7 https://www.nrel.gov/docs/fy19osti/72401.pdf

8 https://www.renewableenergyworld.com/ugc/articles/2019/02/01/massachusetts-becomes-first-in-the-nation-to-make-battery-storage-eligible-for-energy-efficiency-inc.html

9 National Hydropower Association (NHA) (2012) Challenges and Opportunities for New Pumped Storage Development.

10 http://css.umich.edu/factsheets/us-grid-energy-storage-factsheet

11 Centre for Sustainable Systems, University of Michigan

12 The AI helps to store the energy when it is affordable and uses the same when the cost and demand of electricity is at the peak as it has the potential to optimise the size and maximise the returns.

13 https://www.energy-storage.news/news/massachusetts-policy-leads-stem-towards-28.2mwh-of-solar-co-located-energy

14 http://www.energy-log.in/indias-first-grid-tied-energy-storage-plant-inaugurated-delhi/

15 https://www.livemint.com/

16 https://www.greentechmedia.com/articles/read/indias-energy-storage-market-finally-starts-to-grow#gs.t2r5hk

17 https://www.saurenergy.com/solar-energy-news/focus-on-energy-storage-the-technologies-leading-the-charge

18 http://pib.nic.in/newsite/PrintRelease.aspx?relid=181698

19 http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1567807

20 https://mnre.gov.in/sites/default/files/webform/notices/National-Wind-Solar-Hybrid-Policy.pdf

21 https://mnre.gov.in/sites/default/files/webform/notices/Amendment-in-National-Wind-Solar-Hybrid-Policy.pdf

22 Clause 5.4 of the National Wind-Solar Hybrid Policy.

23 https://www.seriius.org/pdfs/062013_indo_us_pace_report.pdf

24 http://www.dst.gov.in/pressrelease/award-announced-indo-us-smart-grids-and-energy-storage-program

25 https://www.iusstf.org/program/indo-us-joint-clean-energy-research—development-centre

26 https://www.usicef.org/about-usicef/; U.S via Overseas Private Investment Corporation (OPIC) committed investment of US$250mn in financing to help IDFC, expand lending in renewable energy and infrastructure projects solving out the cost challenges in deployment of projects. Also, Exim Bank provided financial support to Miasolé, California-based solar module manufacturer to provide thin-film solar panels to a PV project in Rajasthan to leverage the expertise.

27 However, the bill is still not passed by the Congress and was recently tabled before the Congress with some modifications. https://www.heinrich.senate.gov/press-releases/heinrich-introduces-bipartisan-bill-to-create-tax-credit-for-energy-storage https://www.greentechmedia.com/articles/read/congress-introduces-energy-storage-tax-credit-bill#gs.u967bw

28 Niti Ayog Paper

29 id

30 https://www.crisil.com/en/home/newsroom/press-releases/2019/02/csr-spend-tops-rs-50000-crore-in-4-years.html

31 https://www.csr.gov.in/developmentlist.php

32 *Ibid*

33 https://www.utilitydive.com/news/california-looks-to-next-steps-as-utilities-near-energy-storage-targets/525441/

34 https://www.world-nuclear.org/information-library/current-and-future-generation/electricity-and-energy-storage.aspx

35 http://www.mondaq.com/unitedstates/x/806632/Renewables/The+Future+of+Energy+Storage+in+the+United+States+is+Bright

36 https://www.ferc.gov/whats-new/comm-meet/2018/021518/E-1.pdf, http://energystorage.org/policy/regulatory-policy/overview-ferc-order-841

37 https://www.bizjournals.com/kansascity/news/2018/05/07/wise-power-energy-storage-crowdfunding.html, https://www.renewableenergyworld.com/articles/2019/01/crowdfunding-sites-that-allow-true-investment-in-renewable-energy-and-sustainability-alternatives-to.html, https://www.smart-energy.com/industry-sectors/distributed-generation/crowdfunding-an-untapped-funding-resource-for-renewable-energy/

38 Currently the discharge time of lithium ion batteries is between 1 min to 8 hours depending on the kind of batteries and the average life of lithium ion batteries is between 15-20 years https://www.eesi.org/papers/view/energy-storage-2019

39 The example can be taken from US when it established SAMTECH. It was a partnership between the government and all the leading players in the market to help US as a leading manufacturer of semiconductors. The government was actively involved in boosting the confidence of companies and research institute by providing the sense of both urgency and commitment. This collaborative partnership helped US government to substantially improve the technology of semiconductors. (Niti Ayog Paper)

40 https://link.springer.com/article/10.1007/s40518-019-00128-1#Sec5

41 https://www.masscec.com/advancing-commonwealth-energy-storage-aces

Sustainable Infrastructure Development in the India-US Indo-Pacific Narrative

Krithika Subramanian
Master in International Affairs Candidate: 2018-2020
Lee Kuan Yew School of Public Policy
National University of Singapore

It needs to be seen how India and the US aim to promote the culture of sustainable infrastructure in Indo-Pacific factoring third country that will address the requirement of the developed, developing and underdeveloped economies.

Infrastructure and connectivity development have long emerged as an important subject matter in India-US cooperation. More important has been their recent mutual resolve to promote sustainable infrastructure. This is aptly reflected in the *Joint Statement* of the India-US 2+2 Ministerial Dialogue that restates the importance of promoting collectively a "transparent, responsible, and sustainable debt financing practices" for infrastructure development with partner countries. While infrastructure has been zeroed in on as a key driver that has the potential to burgeon the uneven balance amongst various aspects such as economics and environment forming the Triple Bottom Line in multiple underdeveloped and developing nations, the need to focus on sustainable infrastructure development (SID) has become a globally significant phenomenon.[1]

It, therefore, needs to be seen how India and the US, as the two ardent advocators of the liberal international economic order, aim to promote the culture of sustainable infrastructure in Indo-Pacific factoring third country that will address the requirement of the developed, developing and underdeveloped economies.

The Indo Pacific region, similar to other geopolitically defined regions, is an artificial construct whose boundaries vary with respect to the geopolitical players involved. The region broadly refers to the idea of both, the Indian and Pacific oceans as a mental map that is carved out of space. This region does not fit into the existing political dimensions of the Asia-Pacific

> Infrastructure and connectivity development have long emerged as an important subject matter in India-US cooperation. More important has been their recent mutual resolve to promote sustainable infrastructure

region. It is the strategic, political and military aspect of this region that has caused it to gain greater prominence.

The term Indo Pacific, in recent years, has gained considerable traction. With respect to the Indian perspective, Prime Minister Narendra Modi, in the 2018 Shangri La Dialogue in Singapore, spelt out the boundaries in an overt, pellucid manner as one that extends from the "shores of Africa to that of the Americas."[2] Modi also emphasised on the inclusivity of India's engagement in the Indo – Pacific region. By recalling India's civilisational ethos of pluralism, coexistence, openness and dialogue, he said that one of India's aims would be to promote a democratic, rules-based order in which all nations thrive as equal and sovereign.

India, however, is not the sole power and its geopolitics is influenced by that of the other regional and extra-regional powers that operate within the neighborhood. With a heady amalgamation of maritime connectivity, infrastructure development, collaboration, cooperation and competition playing an increasingly instrumental role towards the growth of Asia, and more importantly, to that of India, nations in the region are scuffling with the multi-faceted challenges of an increasingly globalised world, and are witnessing a historical restoration of the global balance of power.

As a country with great ambitions for development, and a forthcoming advocate of the Indo-Pacific strategy, it is instrumental for India to take this opportunity in justifying and rationalising its interest in South Asia; and expanding its interest in East Asia and strengthening its multi-faceted cooperation with the US. Though the 2016 Logistics Exchange Memorandum of Agreement; the 2018 Communication, Compatibility, Security Agreement; and the American decision to rename the Pacific Command as the Indo-Pacific has helped in strengthening India's relationship with the US; it cannot be misconstrued as an endorsement of a US-led regional order primarily because the American vision for regional security is firmly rooted in anti-Chinese tendencies rebutting the Indian vision of inclusivity, which views Beijing as an equal partner in bilateral and global affairs.[3]

The Free and Open Indo-Pacific has been identified as a strategic concept that has been emerging as an alternative to the Belt and Road Initiative in countering the rise of China. The American narrative has been focusing on infrastructure and capacity

development in Asia; aptly illustrated in the Better Utilisation of Investment Leading to Development Act (BUILD Act) which identifies India and Japan as key partners.[4]

The dual advantage of the BUILD Act is that, firstly, the government has created tools to support and smoothen the process for American businesses to operate from developing nations. Secondly, it would create opportunities for employment and provide access to electricity, infrastructure and investment in the region, and in time, reduce the dependence on American aid[5]. While this Act does seem promising on multiple fronts, some of the shortcomings and barriers include the lack of focus given to sustainable infrastructure, the first cost premium of the project, lack of stakeholder participation, of transparency and accountability, and most importantly, the lack of knowledge about sustainability.[6]

The Asia Reassurance Initiative Act (ARIA), at the outset reaffirms the American strategic partnership with India which is based on promoting peace and security in the Indo-Pacific region. Calling for further strengthening of the diplomatic, economic and military ties between India and the US, this act identifies the Quadrilateral Security Dialogue shared between the US, Japan, Australia, and India as a vital platform in addressing the pressing security challenges that arise out of the Indo-Pacific. With Donald Trump signing ARIA into a law in December 2018, India is provided with the dual opportunity of leveraging the US into enhancing the defense and security by using mechanisms such as the Defence Technology and Trade Initiative (DTTI) and the STA Tier 1 Status; and in the investment of sustainable infrastructure development (SID) in the Indo-Pacific region as a stepping-stone

in strengthening the endorsement of an American led regional security order. While this Act reiterates India's position of a crucial partner in the region, the two anticipated challenges include a direct confrontation with China and a consequent impact on the Indo-Pacific nations as most of them rely on China for being their largest and reliable trading and development partner; and an acknowledgement of the fact that the US lacks confidence and commitment toward India for neither having economic nor military might in countervailing China in the region.[7]

Though the ARIA and BUILD Act reaffirm American strategic partnership with India in promoting peace and security in the Indo-Pacific region, it is essential for India to acknowledge the potential lack of American commitment and skepticism due to Donald Trump's unpredictability. America's whimsical approach towards the withdrawal of troops and mockingly dismissing the Indian contribution towards Afghanistan; expecting India's relentless and unflinching support in containing Chinese influence; and a paltry US$1.5bn per year pledge under ARIA for development in comparison to a US$25bn investment by China in the CPEC region alone should make New Delhi question America's intent and impact.[8] More importantly, Donald Trump's tariffs on the steel and aluminum imported from India; the increase of tariffs on 14 percent of Indian exports to the US and the withdrawal of India's eligibility under the Generalised Systems of Preferences (GSP) in 2019 has further intensified New Delhi's skepticism towards Washington.[9]

While questioning the American commitment in the region does pose grave questions, India also holds opportunities in strengthening the Indo – Pacific region, specifically in the field of SID through other channels as well. This strengthening, however, comes with the cost of being a part of the Regional Comprehensive Economic Partnership (RCEP) mooted by the ASEAN, and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), originally the Trans-Pacific Partnership (TPP). With Donald Trump pulling the US out of the TPP, the revised CPTPP aims for stricter standards for labor, environmental and conflict resolution mechanisms.[10]

The RCEP, for India, could have been a platform to flex its strategic and economic status in the region, and an opportunity to bring to fruition its "Act East Policy". By addressing pertinent issues such as investment, intellectual property rights and cooperation in different spheres, RCEP would've complimented India's free trade agreements and help strengthen its relationship with the members. With the harmonisation of trade rules, RCEP would have played the role of an effective platform in integrating India into the regional

production network. Given that India already enjoys strong systems in place for communication, technology, healthcare and education. The RCEP would have created opportunities for Indian companies in furthering their access to new markets and SID. The onus, thus, lies upon India and other powers in the region in ensuring that the RCEP is comprehensive and focusses on themes that fall beyond the purview of market access to goods.[11]

For India, CPTPP would have promised a variety of rewards. Given that the bloc constitutes 16 percent of the world economy, India could have potentially plated the role of a leading manufacturer and an export hub for the Pacific region. India already has a stable trade relationship with the CPTPP nations such as Canada, Mexico, and Chile, and with the US hinting at willing to renegotiate an entry into the trade bloc, India could have developed a structured trade pact. Securing a trade agreement with the US and 11 other economies that have immense growth potential is an outlook that would certainly have strengthened the Indian economy.[12]

With pollution plaguing every major city in India, making the air quality almost unbreathable, the Government has had to stall construction. This phenomenon of pollution and poor air quality, however, is not specific to India and is faced by other developing countries like China, Indonesia, and Myanmar. It is at this juncture that sustainable infrastructure development can play a role in minimising energy consumption and carbon dioxide emissions. Employing SID enables job creations, encourages the purchase of local goods and services, enhances the quality of life for citizens and helps in protecting the natural resources and the environment.

This paper thus puts forth three recommendations in ensuring SID is employed in the Indo-Pacific region. Firstly, launching an Indo-Pacific Infrastructure Network which ensures that a country-wise "Sustainable Infrastructure Development Report" is published, which will help in identifying the scale of work that has been undertaken in promoting SID. It will also help in analysing the gaps such as financing and requirements like labor and resources of each city, and governments can thus be well equipped in approaching multilateral organizations, private firms and financial bodies in filling the gaps. In order to provide a checklist of efforts being carried out, recommendations on ways to develop sustainable infrastructure and accountability to funders, this report should be published in a timely manner.

Secondly, the Infrastructure Network will provide tools for governmental representatives from all tiers, starting from the Panchayati Raj to the Members of the

> "The responsibility thus lies in the rest of the developing nations in taking action and invest in sustainable infrastructure in collaboration with nations such as the US before it is too late"

Legislative Assembly in India and its concurrent role sin other developing nations to ensure capacity building, identifying scope for potential SID and working with stakeholders such as the private sector and financial institutions. The Network will develop a standardised toolkit in a nationwide manner and offer both in-person and online training to the representatives in ensuring a uniform approach to tackle potential challenges that may arise.

Thirdly, and most importantly, the Network will design a toolbox in partnership with the governmental and private financial institutions in standardising solutions that address common risks that arise out of sustainability liked infrastructure projects. It is estimated that over US$100tn of funding is required in investing in sustainable infrastructure, transportation and waste management on a global scale Addressing these challenging issues thus requires the cooperation of international stakeholders and financial institutions.

Southeast Asia has already taken steps in encouraging private sector financing such as launching the ASEAN Green Bond Standards in November 2017; the incentivisation process by Indonesia for the production of environmentally friendly vehicles; and the signing of the Declaration on South-South Cooperation by Bhutan, Mongolia, the Philippines and Vietnam. The responsibility thus lies in the rest of the developing nations in taking action and invest in sustainable infrastructure in collaboration with nations such as the US before it is too late.

Endnotes

1 Brenda Mutanu Munyasya & Nicholas Chileshe. "Towards Sustainable Infrastructure Development: Drivers, Barriers, Strategies, and Coping Mechanisms," Sustainability, MDPI, Open Access Journal, vol. 10(12), pages 1-18, 22nd November 2018. Accessed at https://ideas.repec.org/a/gam/jsusta/v10y2018i12p4341-d184692.html

2 Press Information Bureau, Government of India, 'Text of Prime Minister's Keynote Address at Shangri La Dialogue', 1st June 2018. Accessed at http://pib.nic.in/newsite/PrintRelease.aspx?relid=179711

3 Jagannath Panda "Does India endorse a US – led regional order?" East Asia Forum, 23rd September 2018. Accessed at https://www.eastasiaforum.org/2018/09/23/does-india-endorse-a-us-led-regional-order/

4 Nidhi Varma "The Strategic and Economic Dimensions of Indo – Pacific", Brookings, 5th April 2019. Accessed at https://www.brookings.edu/events/the-strategic-and-economic-dimensions-of-the-indo-pacific/

5 Samantha Urban, "What is the BUILD Act?" One Org, 10th April 2018. Accessed at https://www.one.org/us/blog/build-act-questions-development-entrepreneur/

6 YH Ahn, AR Pearce, Y Wang and G Wang "Drivers and barriers of sustainable design and construction: the perception of green building experience." International journal of sustainable building technology and urban development, 2013, v. 4, no. 1, p. 35-45. Accessed at http://ira.lib.polyu.edu.hk/handle/10397/24881

7 Col Rajeev Kapoor "Asia Reassurance Initiative Act (ARIA): What it means for India" Center for Land Warfare Studies, 14th January 2019. Accessed at https://www.claws.in/1966/asia-reassurance-initiative-act-aria-what-it-means-for-india-col-rajeev-kapoor.html

8 Ibid.

9 Chad P. Brown, "Trump's Mini Trade War with India", Peterson Institute for International Economics, 8th July 2019. Accessed at https://www.piie.com/blogs/trade-and-investment-policy-watch/trumps-mini-trade-war-india

10 Meaghan Tobin, "The Difference Between RCEP and CPTPP" South China Morning Post, 6th July 2019. Accessed at https://www.scmp.com/week-asia/geopolitics/article/3017487/explained-difference-between-rcep-and-cptpp

11 Bipul Chatterjee and Surender Singh, "Why RCEP is Vital for India" The Diplomat 3rd March 2015. Accessed at https://thediplomat.com/2015/03/why-rcep-is-vital-for-india/

12 Divesh Kaul, "How is India Navigating Global Trade Agreement Trends" The Diplomat, 8th December 2018. Accessed at https://thediplomat.com/2018/12/how-india-is-navigating-global-trade-agreement-trends/

MISCELLANEOUS

James Crabtree
Associate Professor in Practice Lee Kuan Yew School of Public Policy
National University of Singapore

A Long March to High-Tech Self-Reliance Would Hold Back China

A chipset designed by HiSilicon: China's state-led attempts to develop advanced chipmaking capabilities have been expensive failures.

Self-reliance strikes a powerful cultural chord in China, bringing to mind 1940s slogans coined by Mao Zedong as he ground out bloody victories in the country's civil war. Over recent months the notion has enjoyed a resurgence, reawakened by President Donald Trump's moves to deny critical technologies to companies like Huawei in the ongoing US-China trade war.

It is hardly surprising that China's leadership find such threats unacceptable, and thus is talking up its ability to develop indigenous technologies in areas like semiconductors. But that does not make the idea of a push for technological self-reliance any more sensible, given the most plausible route to rapid Chinese development still lies with greater integration with the world economy, not less.

China's Vice Premier Li Keqiang made no mention of self-reliance when he spoke at the July 1-3 "Summer Davos" meeting of the World Economic Forum in the coastal city of Dalian. Instead, against the backdrop of a slowing Chinese economy and falling foreign investment, Li pledged to accelerate China's openness to international companies in sectors such as financial services.

President Xi Jinping has made frequent mentions of the idea over recent years, however, notably in a speech last September, in which he suggested China would be forced to take "the road of self-reliance" as it attempted to become an advanced nation. Coming at a time of worsening trade tensions with the U.S., his remarks were viewed as a call for Chinese technological independence in an era of rising protectionism.

The decision by Xi and Trump at the G-20 summit in Osaka in late June to resume trade talks and avoid further tariffs, at least for now, will do little to stem this feeling of Chinese vulnerability. Trump has proved himself thoroughly unpredictable, and temporary cessations of hostility can be quickly undone.

> It is hardly surprising that China's leadership find such threats unacceptable, and thus is talking up its ability to develop indigenous technologies in areas like semiconductors

Although a world leader in sectors from high-speed rail and electronic payments to supercomputers, China remains reliant on foreign know-how in many others. Semiconductors are a particular weak point, as the US threats to deny components to both Huawei Technologies and ZTE, another telecom group, have shown.

"These attacks on Huawei have been a massive wake up call to business leaders and politicians about the reality of China's position," I was told on the sidelines of the Dalian gathering by Nina Xiang, author of Red AI, a new book about her country's stubborn technological limitations in areas from artificial intelligence to robotics. Whatever its chances of success, a renewed push to develop indigenous technologies are now all-but inevitable, she suggests.

In all this, the US and China find themselves in a curiously symmetrical position, as hard-liners in both nations come to fear the other side turning economic interdependence into a weapon.

Trump's advisers point to China's frequent use of economic coercion as a tool of diplomacy, from recent threats to limit supplies of rare earth metals to its temporary ban of Australian coal imports in February, following Australia's decision to block Huawei's involvement in developing fifth-generation wireless networks. They conclude, the US must — through greater self-reliance, in a sense — take steps to avoid being put in a similar position as China's economic sway increases.

Trump's recent actions have led China's leaders to reach a similar conclusion. The resulting fog of mutual distrust has led some to predict the two nations might decouple, creating something akin to the two entirely separate economic zones of the Cold War.

This outcome has never been likely, at least in the short term, given how complex and entangled the duo's economies have become. But a smaller and more gradual process of separation between the US and China is quite plausible, reversing some of the rapid integration that developed over a couple of decades of globalisation.

This needs not to be a catastrophe for either side, but it would hurt China in particular, if it made it harder for Chinese companies to gain access to the kind of technologies they need to compete with the world's best.

Most Chinese industries remain deeply dependent on foreign know-how. Its corporations paid $29 billion worth of licences and royalties for intellectual property in 2017, more than half of which

came from the US, Germany and Japan alone, according to a new report released at the world economic forum by McKinsey & Co., a consulting company.

For Beijing's trade hawks this is a rationale for self-reliance. But in truth, China is now likely to need greater exposure to foreign know-how, especially in lagging industries like aircraft manufacturing or advanced industrial materials. In sectors where China is already world-class, such as making high-speed trains, it prospered by bringing in foreign expertise. The sensible approach to areas, in which it is much less good, like making passenger planes, is to do the same.

The notion of self-reliance has already pushed China into bad policy choices and now risks doing so again, with semiconductors the most obvious example. Over recent decades its leaders have launched repeated state-led attempts to develop advanced silicon chipmaking capabilities. Almost all have been expensive failures.

Chinese companies like Huawei's HiSilicon spinoff do now produce chips for use in many of its smartphones and laptops. But the world's most advanced component makers remain in countries like the US. Most analysts agree China remains as much as a decade behind leading rivals like Taiwan's TSMC.

Officially, China wants more than three-quarters of its semiconductors to be made domestically by 2030, up from around a third now. But the odds are slim that it can achieve anything close to this target by throwing around public money or launching further plans in the vein of its existing "China 2025" manufacturing strategy. Even if it did, the remaining imports would almost certainly still be the most important, given they would be the most complex, high-end chips.

McKinsey points to four advantages that helped countries like Japan and South Korea clamber up the tech ladder: sizable investment, large markets, access to advanced know-how and policies that encourage both competition and innovation. China does well on the first two but struggles with three and four.

This leaves China's leaders in a bind. There is not much they can do about America's trade belligerence, beyond continuing to try and strike a deal that might defuse tensions overall. But there is plenty it can do to make its economic system more open to international investment, and its policies less focused on state interference.

Even if this does not placate Trump, it will still help China's economic prospects. If the US grows less willing to develop commercial ties, there are plenty of other advanced countries that will. Either way, encouraging Chinese companies to remain enmeshed in global networks of trade and innovation remains the most likely route to development. A return to Mao-era slogans is hardly likely to do the trick.

The article first appeared in Nikkei Asian Review on July 04, 2019

Vijaya S Iswara
Creator, FastFix

Building Smart and Sustainable Infrastructure

In recent decades, many nations transformed themselves from agrarian societies to industrial powerhouses. Some adopted an ideology of mercantilism, some resisted meaningful transformation to modernity while most others continue to look for a middle path that is palatable to local populations.

It is essential to identify, preserve and cherish core cultural values of a nation and decide what should remain in the non-negotiable part of national DNA. Trade must be free of external influence, short-term political exuberance, economically fair, operationally efficient, financially transparent and mutually beneficial.

India is blessed with great talent in many areas, such as maritime, software, engineering, manufacturing, mining, natural resources, etc. The US has complementary resources and pioneering views towards establishing free markets. Both democracies perceive freedom and prosperity of all people is possible through education, trade, investment and cultural exchanges.

Julia Gillard, Australia's former Prime Minister noted: "Economic growth driven by large-scale infrastructure investments without equitable provision of education will leave hundreds of millions of people behind, exacerbating inequality, disillusion, and instability".

Sri Mulyani Indrawati, an Indonesian economist and finance minister noted "Infrastructure alone won't end poverty. The World Bank had to learn this lesson too. While we believed too much in bricks and mortar in our early days, we now understand that bringing together funding, technical expertise, and tested knowledge goes much further."

One of the critical reasons for trade to be opposed in many societies is the fear of losing existing sustenance. Lack of economic opportunity diminishes the structural norms of a society which, in turn, leads to cultural demise. It accelerates

economic migration. This sentiment produces onerous laws that stifle growth. It can be solved by installing smarter market access methods.

India can learn from other's experiences in reviewing domestic infrastructure projects. Boomtowns of past decades in the US that went bust due to vagaries of market forces, poor regulations and plain old policy level ignorance provides a great example.

For India to experience and sustain attractive growth rates, it is an existential necessity to have a core motivational attitude shift at the policy level. She must engage in a fundamental review of the country's strategic rationale for the next 50-100 years, both domestically and internationally.

If the goal of possessing great infrastructure is to assure long-term prosperity then efficiency in deployment of resources, simplified and transparent processes must be paramount.

On the domestic front, India should take a deeper look at what type of infrastructure is needed, to understand true opportunity costs. In strategic terms, sourcing processes for expertise should be equitable in growing domestic talent versus utilising expensive foreign components to satisfy certain global influencers.

It is important to visualize both short/long term goals as well as stated benefits for the country.

Example of goals

- Switzerland: peaceful co-existence
- The US: self-sufficiency plus global dominance
- India: can be the main destination for global trade with mutual benefit

Infrastructure types

Domestic based on:

- Land: roads, bridges, tunnels, energy, (non) renewable resources
- Water: drinking/freshwater, ports, coastal and inland waterways, fisheries, other marine resources
- Air/Space: civil aviation, military, communications, satellites, exploration, cyber
- Administration: borders (states, political, economic etc.), defense, legal, intellectual property, taxes, permits, markets (regulated/unregulated)

International

Global organisations that improve foreign relations issues including:

- Market access (trade in goods and services)
- Defense (security, border disputes, peacekeeping, disaster collaborations)
- Treaties (various aspects)

To explore further

- Land: For any modern free civil society to exist and prosper good land based infrastructure is a necessity. India is a big country with parts of it missing paved roads. This is an excellent opportunity to connect remote parts of the country to avoid mass urbanisation, tasteless overbuilding and eternally choking existing business centers.
- Water: Securing, maintaining and recapturing water for reuse assures peace and prosperity. Ports, inland and coastal transit systems are essential components for cabotage and cross-border commerce that contribute to sustained economic development. Throughput efficiency is a key component of port infrastructure. The capacity building itself does not automatically translate into economic dividends as learned elsewhere. Intelligent, market driven solutions that enable smart connectivity of ports are necessary. India should refrain from

making the mistake of overlooking the pitfalls of trophy investments.

- Air/Space: The infrastructure for civil aviation is overbuilt in America, though many hard to reach places still exist. For India, the goal of civil aviation can be reliable connectivity at an affordable price. Military air operations can be for general peacekeeping, disaster rescue missions and national preparedness.
- India has a proud tradition and unique knowledge of space, navigation, planetary systems, weather, technical competence, mathematical pedigree and spiritual purity to pursue a progressive agenda. This is a critical area to achieve long term self-sufficiency and great collaborations.
- Administration: Functional efficiency may not be identified with typical government operations. But this can be a strong differentiating feature for India's future growth plans.

On legal infrastructure - unclear rules and lack of fast course correction mechanisms are the reason for ongoing chaos and disagreements in any country. When Laws impede business opportunities, it costs productivity and steals a country's growth trajectory. Most people are simply unsure of what is expected of them. That leads to agency problems and misrepresentations. Any Person to Government interaction should be frictionless with a singular goal to reduce

“Building smart next generation global trade infrastructure is the glaring opportunity for India and the US”

all pain points. Transparency and efficiency build trust in dealing with counter-parties.

On the foreign trade front, India was the primary destination since ancient times. India can assert historical, moral and spiritual leadership while investing in technological frameworks to install global trading infrastructure. As original signatories to GATT both India and The US were instrumental in giving the world a framework which became the World Trade Organization (WTO). Recently circa (April 2019) WTO was seeking to embrace technological solutions to fix trade issues in goods and services, among other things. This is an opportunity for India to propose solutions that offer efficient and transparent smart technology-based systems. Emerging blockchain technologies may be embraced with an eye towards expanding economic opportunities to underserved markets and to improve the quality of own sovereign currency. Excessive dependence on narrow band of global currencies is dangerous when central banks continue to prop them up.

From my own experiments with the subject, the entire international trade in goods can be simplified as:

- 195 UN members involved in trading
- 11,000 types of goods (based on HS code)
- 90% gets transported on
- 10,000 ships which call
- 3500 ports

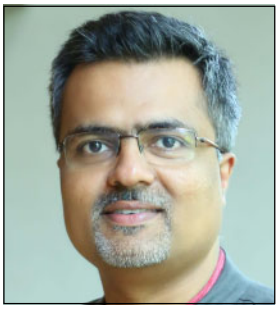
Once we reduce the ‘trade in goods’ universe to concrete numbers like this it gets easier to establish a global trading framework that connects all countries via smart networks.

Trade in services can be reliably delivered using the internet, video conferencing, text messaging and similar channels. Except where physical interaction is necessary for successful outcomes, everything else can be processed efficiently online.

In conclusion, universally-transparent infrastructure backed by smart technologies that consistently deliver unambiguous outcomes can reposition trade decision making back to individual traders and out of stifling forces of the day. Building smart next-generation global trade infrastructure is the glaring opportunity for India and the US.

Creating US-India Bridges through Service, Social Impact, and Innovation

Lessons for the Future



Nishant Pandey
Chief Executive Officer, American India Foundation

Katja Kurz
PhD, Programme Officer of AIF's William J. Clinton Fellowship for Service in India

There is a need and an opportunity to strengthen the India-US relationship at the civil society level.

Historically, the US-India partnership has been strongly rooted in the shared values of democracy and the premise that vibrant people-to-people interactions nurture the bilateral relationship. At the governmental level over the past two decades, this facilitated cooperation in the areas of higher education, science and technology, trade and investment, defense and (cyber) security, technology and energy, environment and agriculture, and public health. Both countries have benefited from this partnership in terms of economic growth and increased mobility. However, these successes are at risk of being undermined by rising isolationism across the world. At the same time, the complex global problems brought on by climate change demand concerted action, which is why civil society is more important now than ever. There is a need and an opportunity to strengthen the India-US relationship at the civil society level. Social impact fellowships are an important tool in sparking innovation.

People-to-People Ties: The Role of International Education and Cross-Country Exchanges for India's Development

Former Foreign Secretary and Indian Ambassador to China and the US Nirupama Rao, who serves on the Board of Trustees for the American India Foundation (AIF) in India, mentioned that "India has not got its

due on the world stage," despite its size, its democracy, and its accomplishments.[1] The strength and vibrancy of people-to-people ties can be measured in the level of interest in and familiarity with each other's culture and language (including history, literature, music, film, geography, politics etc.), as well as the number of cross-cultural exchanges and mobility between the two nations. Unfortunately, the level of people-to-people ties between the US and India remains low.

Despite India being the world's 2nd most populous country[2] and projected to become the 5th largest economy in 2019,[3] US students enroll in Indian language and area studies at startlingly low rates. A 2016 list by the Modern Language Association (MLA) details the 15 most commonly taught languages for US students; no Indian languages appear in this list,[4] even though Hindi alone is the world's 5th most spoken language.[5] The number of US students studying all Indian languages combined was 3,090 in 2013 (0.3 percent of all US language enrollments).[6] In contrast, enrollment for Korean in 2013 was at 12,229 (four times higher), enrollment for Hebrew 19,249 (six times higher), and the enrollment of Arabic 32,286 (ten times higher).[7] Comparing the most recent enrollment numbers from 2016, within three years, the overall enrollment in Indian languages even has decreased.[8]

According to Alyssa Ayres, Senior Fellow for India, Pakistan, and South Asia at the Council on Foreign Relations, this "is a comparative barometer of the low priority Americans place on developing deeper and more place-specific knowledge of India," as compared to other countries in Asia.[9] Lack of interest in Indian language and area studies is problematic, Ayres rightfully points out, since the largest growth in print and electronic media in India "is taking place in languages other than English," which makes it "difficult to access these worlds without any language skills other than English."[10] Similarly, a rising number of civil society groups are mobilising across India in local languages other than English, so lack of language skills also creates a barrier for collaboration and exchange.

International exchanges in higher education are a key indicator of people-to-people ties because it is during this crucial time that the next generation of our workforce is developing key interests and skills that will determine their future choices and career paths. It is crucial which languages they choose to study, which cultures they choose to learn about, and which countries they choose to visit. While Indians are the second largest group of students studying in the US[11], the number of Americans choosing to go to India is extremely small.[12]

India is vastly underrepresented as a receiving country for Americans to study, volunteer, or work abroad, which is a missed opportunity. Less than two percent of American study abroad participants choose India, while double that number choose Costa Rica and Australia, and triple choose Ireland and China.[13] This data reaffirms that "the United States is far more visible in the Indian imagination than India is for the average American."[14]

This lack of interest, combined with administrative, funding, and other challenges, has led to the closing of educational partnerships with institutions in India. Many formerly run study, volunteer or intern abroad programmes in India have been discontinued, leaving Americans with few opportunities to go to India, learn about the region, and build ties with their Indian peers to learn about local innovation such as efforts to combat water scarcity and environmental degradation, reduce plastic waste, and bridge the urban-rural infrastructure gap – all topics that will soon affect the US as well in the context of global climate change.[15] However, the number of studies abroad, work, volunteer, and internship programmes to India has declined over the last decade.[16]

Leveraging Diversity, Equity and Inclusion for Innovation: Closing the Skills Gap

This development has been unfortunate for the advancement of inclusion and equity within the US itself, a country with a diversity paralleled only by India. Studies have shown that service-learning opportunities abroad encourage the US students' academic and professional success, closing the skills gap especially for students from minority communities.[17] International experiences through study abroad have even been proven to increase underrepresented students' timely college completion, resulting in a higher graduation rate than the overall student population.[18] Other data suggests that international education increases employability, intercultural competence, and career prospects for American graduates; an important asset in today's global economy.[19] At this transformative time in our history, it should be a priority to "equip young Americans with the global knowledge needed to work successfully with India," given that India is a key strategic partner and ever-rising global player in the world.[20]

Responding to the US government's call to action, the Institute for International Education (IIE) launched *Generation Study Abroad* in 2014 with the goal of "doubling and diversifying the number of US students studying abroad by the end of the decade."[21] Despite such initiatives, the number of Americans going to India has overall declined. Most Americans are not exposed to India and therefore do not grasp the challenges to grassroots solutions for sustainable development. There is a leadership and opportunity gap in the development sector where many at the top are far removed from the groundwork and are not sensitised towards local challenges and local solutions.

To make matters more complicated, today's global challenges require collaborative and inclusive solutions, which

can only be achieved by working together efficiently. People-to-people ties are the bedrock of innovation. At moments of major geopolitical shifts, these ties that sustain shared values and foster collaboration between civil society actors irrespective of the political context. We've seen this throughout post World War II-history with the inception of the Fulbright Programme. Founded in the belief that peace-building relies on mutual understanding and partnerships on a societal level, Fulbright has brought together over 380,000 students, scholars, teachers and researchers through educational exchange across 160 countries to date.[22]

President Truman, Senator Fulbright, as well as lawmakers in the decades since have understood that fellowships, peacebuilding, and innovation are intimately linked, thus they have harnessed the power of mobilising civil society to facilitate service and leadership.

US-India Partnership in Action: The Rise of AIF's William J. Clinton Fellowship for Service in India as a Private Sector Initiative

Similar to Fulbright, AIF has harnessed the power of international exchange to cultivate the value of service and drive social impact through its fellowship programme. AIF, headquartered in New York City, has been weaving the bonds of innovation through citizen diplomacy since its inception in 2001. Former President Bill Clinton and Prime Minister A.B. Vajpayee provided the impetus for the founding of AIF by mobilising leading Indian diaspora leaders in the US to pool their talents and resources to launch AIF. Former Citibank leader Pradeep Kashyap became its founding Executive Director and Lata Krishnan, tech entrepreneur and start-up investor, its founding President, establishing an organisation that is deeply committed to US-India bridge building. From the get-go, the fellowship programme (AIF Service Corps) was at the core of this bridge-building mandate.[23]

In the aftermath of an unprecedented, devastating earthquake in Kutch, Gujarat, President Clinton, at the suggestion of Prime Minister Vajpayee, proposed the idea of sending a group of Americans to India to not only help to rebuild the region and offer relief for earthquake survivors, but also to foster strong ties between civil society in both countries to support mutual understanding and long-term collaboration.[24]

Out of this idea, in 2001 the "AIF Service Corps" was born. When the first few batches of Americans went to India, AIF soon noticed that "disaster relief" is a complex task that requires multi-disciplinary, cross-sectoral solutions that address education, migration, public health, gender equality, children's rights, environmental conservation, and many other challenges long-term. Thus the programme expanded to partner with a variety of grassroots, research, corporate, and public institutions across India to tackle these challenges more holistically and sustainably. To do so, the programme also expanded from a summer-long to a 10-month long commitment. Gradually and organically, the fellowship programme evolved from providing disaster relief to sparking micro-innovations and accelerating social impact in all areas of India's development. In 2009, AIF renamed the programme to the "AIF William J. Clinton Fellowship for Service in India," honoring President Clinton for the role he played in providing some of the founding principles of AIF and the fellowship programme.

In 2011, acknowledging the rising interest among young Indian citizens to serve their country's social development, the program became bi-national, accepting Indian citizens alongside US citizens to serve as AIF Clinton Fellows on the ground. This not only accelerated its impact on the ground

but also increased mutual learning and strengthened the collaboration between emerging U.S. and Indian leaders during the programme.

The AIF Clinton Fellowship is a 10-month volunteer service programme that brings together young professionals from the US and India to serve with the grassroots community and civil society organisations across India to tackle the most pressing challenges in India's development. AIF Clinton Fellows work on scalable and sustainable projects with largely under-resourced development organisations across India. It is designed to shape the next generation of leaders committed to positive social change while strengthening civil society in both the US and India and identifying the most innovative solutions being developed on the ground.

Over AIF's 18-year history, we have learned that civil society is the backbone of innovation in the US and India, which is why we must invest in them. With India gaining prominence, civil society in the US and India can forge powerful alliances to positively shape our future. Thanks to the fellowship programme, AIF has fostered mutual understanding between the people of these two great nations, develop future leaders with an appreciation for the challenges of building resilient societies with dignity for all, and spurred civic engagement toward the greater good. Equally importantly, it has cultivated a dedication to service among the next generation of leaders and innovators.

The 'How' of Driving US-India Exchanges for Innovation: Stories of Impact from the Ground

In President Clinton's words, AIF's fellowship programme "is helping shape the next generation of leaders to possess a strong passion for India and the innovation to find solutions for the problems we face."[25] One such example is AIF Fellow Yael Gottlieb, who in 2006-07 served with Action India, a Delhi-based NGO that would in 2019 win an Oscar for the documentary film "Period. End of Sentence," which documents their journey of setting up a women-owned sanitary pad business.[26]

> "People-to-people ties are the bedrock of innovation."

Reflecting on her experience, Gottlieb found that: "The opportunity to serve in India is invaluable. Living on the ground in a community setting, learning first-hand about the challenges that people face in their everyday lives, and learning about the innovative efforts being undertaken to solve these challenges is an experience that is unique. […] I carry these lessons with me every day."[27] Today, Gottlieb holds an executive role at the International Women's Health Coalition after over a decade of leadership within Human Rights Watch.

Over the past 18 years, AIF has placed many such young American and Indian professionals in service with organisations across India. It has fostered an exchange of technical skills and intellectual resources that aims to build the capacity of Indian NGOs while developing American leaders with a deep understanding of, and continued commitment to, India. To date, 471 Fellows

have served with 208 non-governmental organisations in 23 states in India. The fellowship offered them an unparalleled opportunity to learn from community practitioners and beneficiaries on the ground, rather than applying external solutions irrespective of the cultural setting. Moreover, it has helped to close the leadership gap by sensitising diverse practitioners and immersing them in grassroots development work, challenging their previous conceptions.[28]

They've worked to advance health, education, and economic opportunity for some of the most marginalised communities across India and in some of India's most underserved states. Over the past three years, for example, our Fellows have served with community organisations in Bihar, Odisha, Jharkhand, Chhattisgarh, Assam, Uttar Pradesh, and Haryana. Fellow Tod Etheredge II in 2017-18 developed a society re-entry manual for youth offenders at Tihar Prison in Delhi, to make sure that youth offenders have a second chance at life after serving their sentence.[29]

> "With India gaining prominence, civil society in the US and India can forge powerful alliances to positively shape our future"

Growing up in a country that continues to struggle with criminal justice reform and racial inequality, Tod brought a unique perspective to the project that sparked micro-innovations.[30] He did so in collaboration with the founder of the NGO, Mohit Raj, who himself was an AIF Clinton Fellow in 2013-14. Fellow Minahil Khan, who came of age as the daughter of immigrant restaurant entrepreneurs in upstate NY, in 2017-18 worked with Muslim women entrepreneurs in Delhi's Nizamuddin Basti settlement to launch small pop-up shops for a sustainable livelihood.[31]

Fellow Janan Dave in 2016-17 supported a tech start-up by scaling up life-saving technology for mothers and newborns to reduce infant and maternal deaths, which worldwide are among the highest in India.[32] And former Fellow Priya Charry, a librarian, in 2017-18 designed an inclusive web portal for artists with disabilities to showcase their artworks to a global audience, thereby challenging the prevalent discourse on disability in India.[33] Fellow Prashant Anand, a community organiser and social worker from Uttarakhand, conducted a study to launch a sustainable livelihood project in flood-prone regions in Assam in 2017-18.[34] After this experience, he launched his own NGO to support forest-dwelling tribal communities.[35]

While other international programmes have pulled out of India, AIF has been lucky to sustain and grow the fellowship programme. This success is largely due to the creation of a strong local partner network in India, a concerted institutional commitment to our bridge-building mandate, and the support of key institutional contributors and donors. Each year, we have seen steadily rising application numbers, most notably among Indian applicants, which in itself is an indicator of the rising power of India's young civil society. The programme is highly competitive, with a two percent acceptance rate in the 2017-18 programme year. Despite rising application numbers (in 2017-18: 996 applicants), AIF

has kept the cohort size to 36 Fellows or less to ensure outstanding quality and optimal support for Fellows and partner organisations. In recent years, AIF has focused more strategically on diversifying the candidate pool to encourage more young professionals from historically underrepresented groups in the US and India to serve. Our strategy is simple:

1. Select a diverse cohort of young professionals and local partner organisations in a multi-stage competitive process;
2. Match them with one another while considering the organisational need, support structure, and alignment with Fellows' skill sets and interests;
3. Support and train fellows and host organisations to build cross-cultural partnerships and to foster mutual learning through immersive, hands-on project work, a skills-building curriculum, and mentorship;
4. Identify and record best practices and disseminate them through publications and events open to the general public.

Through this method, we have leveraged the power of citizen service for social impact and innovation.

The Long-Term Impact of US-India Civil Society Ties on Development: Stories of Innovation

The impact of the programme far surpasses the 10-month projects that AIF Clinton Fellows work on during their service year. In a survey conducted in 2017, we found out that nearly 75 percent of AIF Alumni have continued in a career of service.[36] Specifically, nearly 40 percent of respondents work in development while another 36 percent collectively work in allied professions, e.g. having started their own non-profits, working in public service, and continuing to volunteer with communities.[37] More than half (54 percent) of Alumni maintain active contacts in the US or India from the Fellowship.[38] Alumni have made an impact across sectors and disciplines. The largest number of Alumni work in education, followed by health services, livelihoods (economic empowerment), and social and legal services. Others work in government, arts and culture, human rights, environmental conservation, gender studies, and disaster relief.[39]

Like Gottlieb, who was mentioned at the beginning of this article, there are many other Alumni who have become influential change-makers driving innovation. Ajaita Shah served as an AIF Fellow with Unitus Ujjivan Financial Services on a microfinance project in the early years of the programme, in 2006-07. Her experiences fueled her to start her own social enterprise called Frontier Markets, which is a rural marketing, sales, and service distribution company providing access to affordable and quality consumer durables to low-income households while also focusing on products in clean energy, agriculture, health, and water sanitation.[40] In 2017, Shah was named the grand champion of the Global Innovation through Science and Technology competition at the Global Entrepreneurship Summit.[41] She won the competition among hundreds of peers from 65 countries.[42] Since its inception in 2011, Frontier Markets has built a network of over 5,000 rural women entrepreneurs, revolutionising the landscape of renewable energy.[43]

Dianne Coffey in 2008-09 served as an AIF Fellow with the Yusuf Meherally Centre in Kutch, Gujarat. Working with survivors of the 2001 earthquake, Coffey's project focused on health care, education, empowering women and indigenous communities, and promoting income-generating activities as part of the centre's relief efforts. It provided her with the opportunity to learn about the

> The AIF Clinton Fellowship is a unique template for harnessing the poCwer of people-to-people ties through leadership development and capacity building to strengthen US-India innovation

intersectionality of these challenges and how disaster relief requires a multi-sector approach. Her work as a Fellow informed her later Ph.D. dissertation at Princeton University. She published *Little Women: Essays on Maternal Nutrition, Social Hierarchy, and Health in India*.[44] In 2013, she founded the Research Institute for Compassionate Economics (RICE) in Goa to advance this research further. Under Coffey's leadership and with a 1.3 million dollar grant from the Bill and Melinda Gates Foundation,[45] the institute conducted large-scale sanitation research in India, which culminated in an award-winning book called *Where India Goes: Abandoned Toilets, Stunted Development and the Costs of Caste*, published in 2017.[46] Shedding light on the paradox of open defecation in India, the book has been praised by critics as essential reading for policymakers.[47]

Gaurang Raval in 2012-13 served as an AIF Fellow with Utthan, a youth organisation working with indigenous communities in rural Gujarat. His experience as an AIF Fellow inspired him to restructure the Sauhard youth fellowship programme that he had founded shortly before becoming a Fellow, to include best practices from the AIF Clinton Fellowship in terms of programme design and impact.[48] He scaled up operations to expose young people to service and grassroots community work while they attend college. Sauhard has built a movement transforming young people into active citizens, building a nation where they can achieve their aspirations.[49] Through a creative skills-building curriculum and spaces to discuss young people's roles and responsibilities in India's democracy and development, Sauhard involves youth in solving social and political issues.[50] In 2017, Raval received the Ashoka Fellowship for his work with Sauhard.[51]

Like Raval, Gayatri Agnew served in 2012-13 as an AIF Fellow with the National Council on Skill Development in Maharashtra. This exposed her to the opportunity and challenges of skilling in India and its impact on local economies. After returning from India to her home in the US, she became a leader in corporate philanthropy and workforce development. In 2013, she joined the Wadhwani Foundation to invest in innovations in vocational education in the US. A year later, she began her tenure with Walmart in Bentonville, Arkansas, to provide strategy and oversee grant-making in economic and global workforce development, veteran reintegration, diversity, and inclusion.[52] She has been a champion of fostering economic development through skills-building and

workforce education.[53] She also became involved in public service. In 2018, she ran for the office of State House Candidate in Arkansas District 93.[54] If she had been elected, Agnew would have been the first woman to hold this seat as well as the first Asian American woman to serve in the Arkansas State Legislature.

The AIF Clinton Fellowship supports an innovation route to development by investing in emerging leaders at a crucial point in their lives. What they experience and learn during the AIF Clinton Fellowship fundamentally shapes the path for their future development, and their role in civil society as informal US-India ambassadors dedicated to sustainable development. This is a unique template for harnessing the power of people-to-people ties through leadership development and the capacity to drive US-India innovation. People-to-people ties matter, which is why we need to invest more in them. Over our 18-year history, these are the lessons we have learned from running a social impact fellowship:

1. **Foster innovation through on-the-ground service:** Solving our global challenges today requires concerted action. It requires not only pooling together diverse talent from across disciplines but more importantly, it requires innovators who understand cultural nuances and can navigate localisations when designing solutions. The latter is not something that can be studied but has to be acquired through field experience on the ground.
2. **Invest in young people under 35:** It is important to invest in emerging leaders at a formative time in their professional careers, i.e. in their 20s and 30s. At this stage, they have enough knowledge and experience to add value to initiatives while also having the flexibility to course-change their careers to advance US-India relations further.
3. **Be intentional in designing learning and reflection:** We've found that a 10-month-long engagement provides a meaningful platform to foster mutual learning, add value to local organisations, and build lasting ties. However, reflection has to be facilitated at crucial points of the programme to foster true learning. We have designed week-long reflection and skill-building seminars at the beginning, middle, and end of the programme which, together with mentorship and coaching, has amplified learning of both Fellows and our partner organisations.
4. **Leverage diversity in every sense:** We have found that a cohort representing the diverse talent from both countries has not only enriched the programme and fostered meaningful long-term US-India collaboration, but also created more innovative micro-solutions for our partner organisations on the ground.
5. **Seek out grassroots implementation organisations:** Partnering with a variety of institutions in our history, we have found that local implementation organisations that are at the verge of scalability derive the highest value from hosting a Fellow, so placing Fellows with such organisations results in the most transformative learning opportunities for both sides. Finding partners in this transitional phase is not always easy, but worth it.
6. **Invest in long-term cross-cultural collaboration:** Investing in individuals can feel like a risk because each person is unique and the desired outcome is not always guaranteed. However, we have seen investment in our Fellows go well beyond the 10-month projects, positively affecting partner organisations. The impact of such investment long outlives the programme duration.

Endnotes

1 Ayres, Alyssa. *Our Time Has Come: How India Is Making Its Place in the World*. New York: Oxford University Press, 2018. Page 7.

2 United Nations Department of Economic and Social Affairs. *World Population Prospects 2019: Highlights*. New York: United Nations, 2019. Page 12.

3 McRae, Hamish. "India Is Set to Take the UK's Place as the World's Fifth Largest Economy: But Is It Really All down to Modi?" *The Independent*, 23 Apr. 2019. https://www.independent.co.uk/voices/india-elections-modi-economy-growth-uk-a8882581.html.

4 Looney, Dennis, and Natalia Lusin. "Enrollments in Languages Other than English in United States Institutions of Higher Education, Summer 2016 and Fall 2016: Final Report." *Modern Language Association*, June 2019. Page 32. https://www.mla.org/content/download/83540/2197676/2016-Enrollments-Short-Report.pdf.

5 McCarthy, Niall. "The World's Most Spoken Languages." *Statista*, 12 Feb. 2018. https://www.statista.com/chart/12868/the-worlds-most-spoken-languages.

6 Supra Note 1. Page 237.

7 *Ibid*

8 Supra Note 1. Pages 24, 51-70.

9 Supra Note 1.

10 *Ibid* Page 236-37; And: Tharoor, Shashi. "There's One Country in the World Where the Newspaper Industry Is Still Thriving." *World Economic Forum*, 24 May 2017. https://www.weforum.org/agenda/2017/05/despite-the-decline-of-printed-papers-theres-one-place-that-is-bucking-the-trend.

11 Institute for International Education. "Top Ten Origin International Students, 2018." Open Doors Report 2018. Fact Sheets and Infographics. https://www.iie.org/Research-and-Insights/Open-Doors/Fact-Sheets-and-Infographics/Infographics/International-Student-Data.

12 *Ibid*

13 *Ibid*

14 Supra Note 6 Page 213.

15 Shah, Rajiv J. "What the U.S. Can Learn from India on Climate Change and Energy Access." Rockefeller Foundation, 27 June 2017. https://www.rockefellerfoundation.org/blog/u-s-can-learn-india-climate-change-energy-access; and: Arya, Divya. "The Indian Women Lighting the Way for Change." BBC News, 22 June 2018. https://www.bbc.com/news/business-43837484.

16 Chow, Patricia, and Kimberly Cho. *Expanding U.S. Study Abroad to India: A Guide for Institutions*. IIE Study Abroad White Paper Series 8. Institute of International Education, July 2011. Page 4, 19-20. file:///C:/Users/Katja/Downloads/Expanding-Study-Abroad-India-final-version.pdf.

17 Sweeney, Karyn. "Inclusive Excellence and Underrepresentation of Students of Color in Study Abroad." *Frontiers: The Interdisciplinary Journal of Study Abroad*, vol. 23 (Fall 2013). https://files.eric.ed.gov/fulltext/EJ1062148.pdf.

18 O'Rear, Isaiah, Richard L. Sutton, and Donald L. Rubin. "The Effect of Study Abroad on College Completion in a State University System." *University of Georgia*, 1 Apr. 2011. https://glossari.uga.edu/wp-content/uploads/downloads/2012/01/GLOSSARI-Grad-Rate-Logistic-Regressions-040111.pdf; And: Xu, Min et al. "The Impact of Study Abroad on Academic Success: An Analysis of First-Time Students Entering Old Dominion University, Virginia, 2000-2004." *Frontiers: The Interdisciplinary Journal of Study Abroad*, vol. 23 (Fall 2013). https://files.eric.ed.gov/fulltext/EJ1061987.pdf.

19 NAFSA. "Independent Research Measuring the Impact of Study Abroad." https://www.nafsa.org/policy-and-advocacy/policy-resources/independent-research-measuring-impact-study-abroad.

20 Supra Note 6. Pages 213, 239.

21 IIE Generation Study Abroad Initiative.Institute for International Education, 2019. https://www.iie.org/programs/generation-study-abroad.

22 United States Department of State, Bureau of Educational and Cultural Affairs. "Fulbright Alumni." https://eca.state.gov/fulbright/fulbright-alumni.

23 American India Foundation: Long Distance Philanthropy Brings Donors Closer to Home. Synergos, 2002. https://www.synergos.org/news-and-insights/2002/american-india-foundation-long-distance-philanthropy-brings-donors-closer.

24 Kashyap, Vijayalakshmi. American India Foundation. 3 July 2002. https://indiacurrents.com/american-india-foundation.

25 Clinton: Young Generation Has Potential to Change Lives. *Rediff News*, 12 May 2009. http://news.rediff.com/slide-show/2009/may/12/slide-show-4-clinton-at-aif-gala.htm.

26 Joshi, Namrata. "India Shines at Oscars, 'Period. End of Sentence' Wins Documentary Short Subject." *The Hindu*, 25 Feb. 2019. https://www.thehindu.com/entertainment/movies/india-shines-at-oscars-period-end-of-sentence-wins-documentary-short-subject/article26361692.ece.

27 AIF New York Spring Awards Gala Showcases William J. Clinton Fellowship for Service in India. *American India Foundation*, 14 May 2012. https://aif.org/american-india-foundation-showcases-clinton-fellowship-at-annual-new-york-gala.

28 Nair, Vandana Nadig. "Lessons in Leadership Building." *India Development Review*, 13 Feb. 2018. https://idronline.org/lessons-leadership-building; And: Suarez, Cyndi. "The Nonprofit Racial Leadership Gap: Flipping the Lens." *The Nonprofit Quarterly*, 8 June 2017. https://nonprofitquarterly.org/nonprofit-racial-leadership-gap-flipping-lens.

29 Etheredge II, Tod. Schooling to a New Life. American India Foundation, 11 May 2018. https://aif.org/schooling-to-a-new-life.

30 Nellis, Ashley. *The Color of Justice: Racial and Ethnic Disparity in State Prisons*. The Sentencing Project, 14 June 2016. https://www.sentencingproject.org/publications/color-of-justice-racial-and-ethnic-disparity-in-state-prisons; And: Ghandnoosh, Nazgol. Black Lives Matter: Eliminating Racial Inequity in the Criminal Justice System. The Sentencing Project, 3 Feb. 2015. https://www.sentencingproject.org/publications/black-lives-matter-eliminating-racial-inequity-in-the-criminal-justice-system; And: Gramlich, John. The Gap between the Number of Blacks and Whites in Prison is Shrinking. Pew Research Center, 30 Apr. 2019. https://www.pewresearch.org/fact-tank/2019/04/30/shrinking-gap-between-number-of-blacks-and-whites-in-prison.

31 Khan, Minahil. What Growing Up in My Parents' Restaurant Taught Me about Access to Childcare. *Brown Girl Magazine*, 1 Sept. 2018. https://www.browngirlmagazine.com/2018/09/what-growing-up-in-my-parents-restaurant-taught-me-about-access-to-childcare.

32 American India Foundation. Janan Dave: AIF Clinton Fellow 2016-17. YouTube, 3 Aug. 2017. https://www.youtube.com/watch?v=NWSIO2R_E_g.

33 Charry, Priya. Visual Art Instruction for the Visually Impaired. American India Foundation, 23 May 2018. https://aif.org/visual-art-instruction-for-the-visually-impaired.

34 Anand, Prashant. "Development Debates, Disaster and Assam: Chapter VI – Grassroots." American India Foundation, 18 May 2018. https://aif.org/development-debates-disaster-and-assam-chapter-vi-grassroots.

35 About Us. Samanta Foundation, 2019. https://www.samanta.org.in/who-we-are.

36 Alumni Impact Survey for Expansion. American India Foundation, March 2017. Page 2.

37 *Ibid*. Page 3.

38 *Ibid*.

39 *Ibid*. Pages 2-3.

40 The Story. Frontier Markets, 2019. https://frontiermkts.com/about.

41 P.S., Lakshmi. Ajaita Shah from India Named Champion at GIST Catalyst Pitch Competition at Global Entrepreneurship Summit. *American Bazaar*, 1 Dec. 2017. https://www.americanbazaaronline.com/2017/12/01/ajaita-shah-india-named-champion-gist-catalyst-pitch-competition-global-entrepreneurship-summit.

42 Supra Note 41

43 Supra Note 40

44 Coffey, Dianne. *Little Women: Essays on Maternal Nutrition, Social Hierarchy, and Health in India*. Princeton: Princeton University, 2015. https://dataspace.princeton.edu/jspui/handle/88435/dsp01m613n089v.

45 Mission. Rice Institute, 2019. https://riceinstitute.org/about/mission.

46 Sharma, Sudhirendar. Review:Where India Goes by Diane Coffey and Dean Spears. *Hindustan Times*, 10 Nov. 2017. https://www.hindustantimes.com/books/review-where-india-goes-by-diane-coffey-and-dean-spears/story-hmPNNRSt43IAGB5SqOYpnL.html.

47 Nair, Govindan. "'Where India Goes' Gives a First-Hand Analysis of India's Poor Early-Life Health and Stunting." The Wire, 17 Sept. 2017. https://thewire.in/books/where-india-goes-diane-coffey-dean-spears.

48 Kurz, Katja. "Impact Fellowships: The Secret Lies in the Structure." American India Foundation, 6 Feb. 2018. https://aif.org/impact-fellowships-the-secret-lies-in-the-structure.

49 Gaurang Raval. Ashoka, 2017. https://www.ashoka.org/en-AT/fellow/gaurang-raval.

50 Sauhard Youth Fellowship. Sauhard.org, 2019. https://sauhard.org/sauhard-youth-fellowship.

51 Supra Note 49.

52 Gayatri Agnew. Higher Learning Advocates, 2019. https://higherlearningadvocates.org/team/gayatri-agnew.

53 Varoquiers, Carrie. Workday Podcast: Opening Doors to Opportunity at Walmart. Workday.com, Oct 2, 2019. https://blogs.workday.com/workday-podcast-opening-doors-to-opportunity-at-walmart.

54 Sohrabji, Sunita. Gayatri Agnew Aims for Arkansas State House Seat on Platform of Expanding Economic Opportunity for Working Class. *India-West*, 1 Oct. 2018. https://www.indiawest.com/news/global_indian/gayatri-agnew-aims-for-arkansas-state-house-seat-on-platform/article_09db1bf2-c5b2-11e8-9a35-87827a03b86d.html.

Fostering the Industrial Growth of Rajasthan

RIICO is a premier agency of the Government of Rajasthan for providing industrial infrastructure and project finance.

348 Industrial Areas over 84,000 Acres of land all across the State with well developed infrastructure including..

- **Special Economic Zones** (Jaipur)
- **Agro Food Parks** (Kota, Jodhpur, Sriganganagar and Alwar)
- **Export Promotion Industrial Parks** (Jaipur, Jodhpur and Neemrana)
- **Information Technology Parks** (Jaipur, Jodhpur, Kota and Udaipur)
- **Gems and Gold Jewellery Complex** (Sitapura- Jaipur)
- **Leather Complex** (Manpur Macheri - Jaipur)
- **Country Specific Industrial Enclaves** (Japanese Zone, Neemrana)
- **Honda Zone** in Tapukara, Bhiwadi.

Rajasthan Samwad

RIICO
GROW WITH RAJASTHAN

Rajasthan State Industrial Development & Investment Corporation Ltd.

Udyog Bhawan, Tilak Marg, Jaipur - 302005 | **Ph.:** 0141-2227751, 4593201
Fax: 0141-4593210 | **website:** www.industries.rajasthan.gov.in/riico

ISBN 978 81 8257 282 9

CUTS International

D-217, Bhaskar Marg, Bani Park, Jaipur 302 016, India
Ph: 91.141.228 2821, Fax: 91.141.228 2485
Email: cuts-washington@cuts.org, Website: www.cuts-wdc.org
Also at Delhi, Kolkata and Chittorgarh (India); Lusaka (Zambia); Nairobi (Kenya); Accra (Ghana); Hanoi (Vietnam); Geneva (Switzerland) and Washington DC (USA).