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DEPARTMENT OF ECONOMIC AFFAIRS

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

DRIVING INNOVATIONS IN INFRASTRUCTURE:
THE STARTUP WAY

INVEST INDIA
NATIONAL INVESTMENT PROMOTION
& FACILITATION AGENCY

IIG INDIA INVESTMENT GRID

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FOREWORD

Strong and vibrant national infrastructure is the baseline foundation of a self-reliant nation and is the harbinger of growth and higher standard of living for its citizens. As India grows, so does the need for commensurate infrastructure. To fulfil this growing need, several initiatives have been taken by the government like the National Infrastructure Pipeline (NIP), National Monetisation Pipeline, National Infrastructure Master Plan (Gati Shakti), etc. Hon'ble Prime Minister's Gati Shakti Master Plan intends to serve as "the foundation for holistic infrastructure and give an integrated pathway to our economy." Achieving this hinges directly on the use of technology in Infrastructure.

Achieving growth at such an ambitious pace can only be made possible by innovative ideas and solutions being adopted swiftly at large scale. The quality of life and ease of living that can be supported would be significantly higher if technology can be harnessed with public infrastructure. Technology is at the heart of solutions that would make infrastructure services cheaper, faster and efficient. Infra Tech could help achieve lower costs through better design, enable projects attain greater efficiency in operations and maintenance, enhance service delivery, provide higher comfort, convenience and safety for consumers and help achieve environmental, social and economic goals. Hence, it is imperative that India becomes Atmanirbhar or self-reliant in InfraTech.

There is tremendous potential to work with Startups for developing InfraTech, given the high quality of tech entrepreneurs in India and the confidence that Venture Capitalists have in them. Collaborations between infrastructure developers and startups could catalyse India's infrastructure growth story, besides leading to increased project exports. Indian startups have witnessed tremendous success in recent years. Government entities such as Infrastructure CPSEs must seize the opportunity to forge collaboration with demonstrated InfraTech startups and also incubate promising ones.

Department of Economic Affairs and India Investment Grid (IIG set up by Invest India) have collaborated to organise a workshop on "Supporting Startups in Infrastructure" so as to motivate the Central Line Ministries and Infrastructure CPSEs for adoption of innovative technological solutions and to boost mainstreaming of innovation in the infrastructure sector. This InfraTech report released on the occasion of the workshop, showcases promising startups in certain sectors which are critical to infrastructure. I am sure that the startups featured in this report are but a few examples of the purposeful work being done by startups in the infrastructure aligned sectors.

I am hopeful that the workshop and this Report would manifest in strong partnerships with more innovative startups in the infrastructure sector coming to the fore. This would be beneficial in the delivery of quality infrastructure at affordable costs and would contribute to a more sustainable future, culminating in the realisation of the vision of 'Atmanirbhar Bharat'.

AJAY SETH
SECRETARY,
DEPARTMENT OF ECONOMIC AFFAIRS,
GOVERNMENT OF INDIA

SPECIAL MESSAGE

At the global stage, startups are pioneering new technologies and innovative service delivery solutions. In the infrastructure space, these innovations are shaping the future of infrastructure development and delivery. With government support, these innovations can play a crucial role in developing robust public infrastructure in India, which will support the quality of life and the nation's burgeoning economy.

Digital technologies can integrate disparate infrastructure elements to enable disruptive efficiency gains for primary, manufacturing and service sectors. Use of Industry 4.0 technologies and tools such as IoT, RFID, predictive analytics, AI/ML, etc., can save time, reduce wait and down times, reduce or eliminate damage or losses, etc. For example, use of RFID tagged and IoT enabled mobile cold storage systems, say in Kisan Rail, could ensure full shelf life of perishable foods in transport to domestic and international destinations. Integration of Expressway Intelligent Traffic & Electronic Toll Management systems integrated with the GSTN e-way bill and Customs ICEGATE systems can enable non-stop movement of container traffic to ports, cutting down costs of doing business. A lot of these technologies are imported and we need development of domestic sources.

This InfraTech report outlines the value-addition brought about by startups and their combined expertise which could be harnessed for India's infrastructure growth. It also highlights the importance of on boarding these startups in government and public utility agencies for disruption of the traditional infrastructure sector with path breaking

innovations. Lastly, it enlists some startups already present in critical areas of India's infrastructure sector.

All infrastructure Ministries and CPSEs need to work together to accelerate the adoption of disruptive technologies in India's infrastructure sector. I wish both DEA and IIG accolades for organising the workshop on "Supporting Startups in Infrastructure" and I am hopeful that this will go a long way in defining the horizon of startups in he infrastructure space in India.

K RAJARAMAN
ADDITIONAL SECRETARY,
DEPARTMENT OF ECONOMIC AFFAIRS,
GOVERNMENT OF INDIA

PREFACE

India stands at the cusp of rapid urbanisation driven by an influx of modern technology. As the country is focusing on building resilient infrastructure, it is undertaking an increasing number of construction projects. Technological advancement and innovation have together created several opportunities to modernise infrastructure in India by enhancing productivity and efficiency in projects. Disruptive smart technologies including Artificial Intelligence (AI), Machine Learning (ML), AR/ VR, and Internet-of-Things (IoT), along with ongoing innovations in drone technology have transformed infrastructure interaction and management in the country. Capitalising on the rise of novel solutions, India is targeting a USD 5 Tn economy by 2025, backed by strong infrastructure development.

Against this backdrop, the Government of India has planned to spend USD 1.4 Tn on infrastructure, with the objective of promoting sustainable development. The recent adoption of PLI schemes and NIP projects are poised to add to the growth story of India by providing a boost to CAPEX investment in the nation. To avoid delays and ensure timely completion of projects, startups are aiding the progress of infrastructure development by bringing forward innovative solutions and changing the pre-existing trends and norms in the industry.

This report published by the Department of Economic Affairs and Invest India attempts to provide valuable insights into the current state of technology in infrastructure and highlights the increasing need for the adoption of innovation in this space. The report sheds light on some ingenious startups from around the world that are working towards realising the dream of sustainable infrastructure. As one of the largest startup ecosystems globally, India is ready to foster innovation that furthers its economic dream.

We hope this report provides a glimpse of technology advancements in the infrastructure domain, making the sector the engine of growth of India. This report brings to light key initiatives by the government and the increasing involvement of startups that will reshape the InfraTech domain and drive unprecedented sustainable growth.

DEEPAK BAGLA
MD & CEO,
INVEST INDIA

EXECUTIVE SUMMARY

As India experiences rapid urbanization, the infrastructure sector is set to play a very important role in ensuring holistic development across sectors. The sector also holds massive potential as it is yet to undergo a technological transformation which is essential to shape the future of infrastructure development and delivery. The adoption of modern technology alongside traditional methods is crucial for progress and the building of sophisticated and efficient infrastructure.

Technology is increasingly penetrating key sectors and transforming industrial practices. Infrastructure is undergoing swift changes through the emergence of new and innovative technologies. The combination of these two sectors has given birth to a unique domain, InfraTech, that aims to change the status quo by ushering in smart and economical tools in construction. Therefore, it would benefit India to bolster its infrastructure sector in tandem with its development goals and unravel growth potential through InfraTech.

Some key sectors such as Energy, Medical Infrastructure, Civil Aviation, Shipping, Construction and Real Estate etc. are already experiencing an influx of innovative startup ideas, while other infrastructure sectors are slowly adopting new technologies too, to refine their processes and systems. This has also led to a boost in investment in some of these sectors – EdTech was at the spearhead of capital infusion during the pandemic. Even conventionally less digitized sectors like Agriculture and Food Processing are using technologies like Artificial Intelligence, Internet of Things (IoT), and Cloud-based Management Systems to ensure food safety,

quality and the reduction of wastage. Tourism is another sector experiencing a surge in ideas as hotels rush to open their doors by offering touch-free experiences and setting up contactless processes.

Startups are playing a vital role in navigating India's accelerating development. The Indian startup ecosystem is the third largest globally, with 26 unicorns registered in 2021 alone, bringing the total unicorn count to 63. InfraTech is one of the growing sectors seeing budding startups. Startups are undertaking innovations in different areas of infrastructure in their zeal to mitigate the problems that currently plague the industry and solidify the industry's trust in the Indian startup ecosystem.

To define a new growth story of infrastructure in India, stakeholders across the sector need to provide the necessary impetus to increase its pace of development. The success of the InfraTech adoption and utilization is dependent on a seamless collaboration between the government, corporate players in infrastructure and technology domains, and startups that will bring in their fresh take on InfraTech.

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WHAT IS INFRATECH?

'InfraTech' is the deployment or integration of digital technologies with physical infrastructure to deliver efficient, connected, resilient and agile assets. Technology is increasingly making its way into every field and industry. Everything from airlines to telecoms, and even the way we design our cities, is being shaped by technology.

The word 'InfraTech' itself makes the collaborative nature of the sector evident. Two long functioning industries – infrastructure and technology – come together to form this unique sector offering a futuristic model for business processes. Infrastructure remains the least digitised sector even now when it is hard to imagine how businesses functioned in the past without the use of computers and wireless connections. InfraTech domain seeks to alter this status quo by bringing in intelligent, hassle-free and cost-effective technology for construction.

InfraTech encompasses a range of technology solutions designed for different kinds of requirements from security to workforce management to failure prediction and a world of other business simplifying tools. It makes use of AI and Machine Learning to reduce human effort and streamline business processes in a way that leaves more capital and manpower for business driving departments like R&D and further technology development.

It is safe to say that InfraTech is much more a plan as of now than a full-fledged industry. However, with consistent investments underway and growing consensus among stakeholders, InfraTech is on its way to becoming the next big thing of this decade.

TECHNOLOGY TRENDS, DRIVERS AND CHALLENGES

TECHNOLOGY FORCES SHAPING FUTURE OF INFRATECH

While InfraTech offers a wide range of solutions to enhance existing infrastructure provision facilities, there are key areas of technology where InfraTech industry is making fast headways. These technology solutions are already making way into more and more infrastructure development organisations and it is the success of these technologies that will define future large scale adoption of InfraTech into economies.

◼ REMOTE MONITORING USING SENSORS

Probably the most widespread use of InfraTech in any industry is in the form of a remote monitoring system that provides credible and accurate information for site management without having to keep several experienced professionals for the sole purpose of supervision. The manpower can rather be put to productive uses in the firm.

Sensors and Remote Monitoring Systems help solve most of the challenges of site management. A sensor or a monitoring system could help in the following:

- Reducing structural damage caused by natural and man-made elements by recording useful data over time.
- Reducing the various causes of faults while constructing the buildings.
- Increasing security by automating protection and regulating the entry and exit from buildings.
- Providing timely updates on the structure's integrity to follow up on maintenance as necessary.

◼ ARTIFICIAL INTELLIGENCE

In today's day and age any discussion on technology for any purpose is incomplete without mention of AI. The technology of Artificial Intelligence has proved its merit in more than one way and has become an integral part of business management. InfraTech industry is no different with AI being a major contributor to the solutions offered by InfraTech companies.

In a survey conducted by MergerMarket, more then a third of respondents (37%) thought machine learning and AI will be the key to InfraTech expansion in the coming years while 10 percent of the respondents believe that these technologies have already gained significance in the past three years[1]. Machine learning and AI underpin developments that range from predictive maintenance to autonomous operation on metro systems.

The use of Artificial intelligence brings lots of benefits to the table:

a) Detection of Cybersecurity Threats:

The foremost threat to any technology related business is the threat posed by malware and system corruption. While there has been significant progress in detection and restriction of cyber-attacks, it is still considered a major and often high loss causing risk for the technology industry in particular. AI has by far offered the most accurate and reliable solution to this risk and will thus continue to play an important part in the future of InfraTech development.

b) Prediction and prevention of Failure:

Not only does AI help reduce errors during construction, but it can also be used to predict them even before they have the chance of occurring. Human error remains a major unsolved problem in any business and can often cause irreparable damages. On the contrary, AI algorithms may be able to recognize and associate data that predicts failures much before humans are able to do so and can help businesses save millions. Specifically for InfraTech, AI can be designed to predict construction-related errors and future maintenance issues and can be of particular help during natural disasters.

c) Automatic Mitigation:

Once a threat is detected, AI can even be designed to resolve it with minimum or no human interference. Not only does it save an additional cost of potential failure, it also turns the situation back to normal without correction cost.

1. https://www.mergermarket.com/assets/Pinsents_Infratech_Report_Text_FINAL_LR.pdf
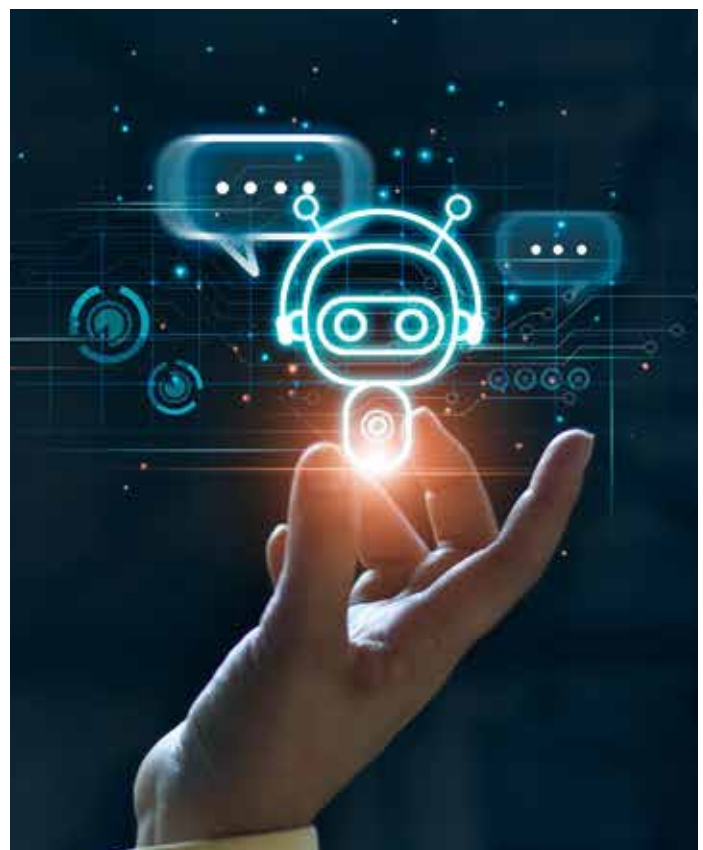
◨ PROJECT MANAGEMENT SYSTEMS

From detecting suitable locations to the procurement of raw material to designing of any structure, there are several stages involved in infrastructure development. The very existence of several steps makes the business prone to delays and inefficiency due to the involvement of many parties. Project Management Systems help in reducing the delays encountered on a construction project. They help keep tabs on one another and improve productivity since things tend to flow naturally as necessary steps are finished one by one. It is an excellent tool for making business processes more structured and also keeps a check on the efficiency of all workers.

◨ COMPUTER VISION

Computer Vision refers to the programming of computers to be able to understand the situation from digital images and videos. When paired with a remote monitoring system such as a surveillance cameras, computer vision can help improve construction workers' safety, increase usage of appropriate construction materials and ensure security of the structure.

◨ WIRELESS NETWORKS

In a survey conducted by MergerMarket, the majority of respondents believe that wireless networks (including mobile, IoT, small cells, and mesh networks) will have a significant impact on infrastructure over the next three years. Four-fifths (80 percent) say these will be among the top three technologies in the coming three years[2], compared to 40 per cent who say they have been key over the previous three. Infrastructure systems that rely on wired networks – particularly standalone networks – will need to be upgraded to wireless sooner rather then later, as infrastructure owners seek to capitalise on the lower costs and greater flexibility offered by mobile communications networks.

2. https://www.mergermarket.com/assets/Pinsents_Infratech_Report_Text_FINAL_LR.pdf

STAKEHOLDER IMPETUS

The three stakeholders in the InfraTech sector are the infrastructure business owners, the technology business owners and lastly the investors for InfraTech business. It is the infrastructure business owners who have to play the most important role in collaboration and it is also this section of stakeholders who is still not very convinced by technology-driven construction and is rather reluctant to invest in that department. There is a definite need for an external push towards a more technology driven approach in the infrastructure sector. The sector stands to gain from this complete revolutionising of procedures but lacks the required R&D to understand its advantages.

Construction technology is supplementing and catalysing infrastructure investments. These technologies, from drone surveying services to 3D printing of construction materials, are expediting construction processes. Research shows that a continuation to full-scale digitization in the design and documentation process could lead to an estimated 12% to 20% increase in the industry's current annual cost savings related to tech tools within the next 10 years.[3] A crucial element of any good marketing strategy in construction is helping potential clients and investors to understand the on-going building process and visualise the finished product. For this purpose, Building Information Modelling (BIM) not only describes every aspect of a development project as it progresses from design and development through to construction, but also provides a platform where information can be shared and updated by all involved.

Technology firms all around the world are known to be more progressive in their business expansion and are the first ones to adopt new practices. There is no doubt that all new markets will open up for tech firms as InfraTech expands and these firms are more eager than ever to reap the benefits of expansion. The best bit about venturing into the InfraTech industry is that it is at such a nascent stage as of now, especially in developing countries like India, that room for making profits is infinite. Large scale infrastructure development is still needed in most parts of the country and the majority of construction-related firms are still new to technology infusion. The firms starting now will certainly get a first mover advantage in such a situation. However, the sheer market size of the industry means that it is far from being saturated in the near future. The current crop of InfraTech startups are being led by firms offering solutions that are speeding up the construction process and improving collaboration between disparate workers. Startups that fabricate building components off-site are able to improve customer supply chains, as entire buildings, can be constructed quickly when the components are received.

3. https://www.constructiondive.com/news/report-how-major-contech-solutions-will-grow-by-2025/576106/

Interest amongst investors is clear. In 2010, VCs invested USD 8.3 Mn globally across just two construction tech deals. The growth in following years yielded USD 1.5 Bn invested across 89 deals in 2018, with the lion's share of funding and media headlines going to Katerra, View, and Procore—which raised USD 865 Mn, USD 1.1 Bn, and USD 75 Mn, respectively.[4] As demand continues to increase, hungry investors are showering construction tech startups with more funding and attention. The Wall Street Journal reports that investors including Goldman Sachs Group Inc. is pouring capital into construction startups, betting that the industry is on the verge of sweeping changes.

The value added by incorporating InfraTech products in everyday operations can make a tangible difference to the entire building process and play a central part in preparing construction firms for a digital-first future. It is an exciting time to be a part of the evolving InfraTech industry. With a largely untapped market, and an influx of interest, funding and opportunities, entering the domain of InfraTech is sure to be beneficial for all parties involved.

ROLE OF GOVERNMENT

InfraTech is still a new and relatively unexplored field in India with a vast growth potential. In such a situation the government will play an important role in the integration of technology and infrastructure firms to develop this new industry. The government seeks to infuse technology in every sector of the economy and infrastructure development through appropriate use of technology is a key goal of the government.

Technology has been the area of focus for the government for the last few years and with the announcement of budget 2021, infrastructure has also become a subject of increased government attention for the coming years. Not only was the capital outlay for the infrastructure sector increased significantly, but several other expectations of the industry were also met. This includes further allocation towards the National Investment and Infrastructure Fund (NIIF) and the setting up of a new development finance institution (DFI). These will augment the financing avenues for the infrastructure sector and can pave the way for increased private participation, thereby supporting the overall infrastructure investment.

4. https://www.cretech.com/cretech-blog/emerging-trends-venture-capital-investment-in-construction-tech/

The government seeks to redefine India's infrastructure capability. And for this, it acknowledges the important role that infusion of technology plays in terms of giving higher results in lesser time. InfraTech industry will primarily be led by private organisations and the role of the government here will be the easing out of this movement from predominantly human-led work to collaborative use of technology. Private individuals and organisations will have their fair share of doubts and a fear of technology adoption due to lack of experience.

Adopting InfraTech is a complex undertaking; oftentimes with no clear understanding of the result. This requires an adaptive approach to project delivery – pivot when required and 'fail fast' if needed.

As a potential investor or end-user in InfraTech, access to an ecosystem of experts across government, industry, technology and academia allows one to do just this. It allows quick gathering of the right kinds of insights at the right time and calls on knowledge and experience of others that have done this before. Identifying viable use cases, defining their value proposition, and demonstrating performance through case studies increases the levels of confidence in InfraTech among industry stakeholders. The aim should be to encourage investors and end-users to take the next step in developing the Infratech project.

The most important role that the government can play is leading by example. Infrastructure development continues to be an important sector for government spending with several projects from urban housing to rural development underway. The National Infrastructure Pipeline (NIP) is India's biggest infrastructure project, to be carried out for a period of five years after its public announcement in 2019. The project aims to provide Indians with world-class infrastructure, improve the quality of life, as

well as attract foreign investments in capital projects. If the government can successfully employ InfraTech in these projects, there will remain no doubts about the efficiency and requirement for technology specifically built for construction purposes. There can't be a more large-scale demonstration of the feasibility of a particular sector than the country's government itself making use of it in its initiatives.

The Smart Cities Mission launched by the Honorable Prime Minister on 25 June 2015 will no doubt make extensive use of technology for building future-ready cities. The main objective of the Mission is to promote cities that provide core infrastructure, clean and sustainable environment and give a decent quality of life to their citizens through the application of 'smart solutions'. The purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Further use and advertisement of such technology can bring big businesses to InfraTech sector.

Ultimately the success of InfraTech industry depends on collaboration between infrastructure development firms and technology development firms. Such collaboration is oftentimes not easy due to the vast differences between the two industries and the consequent lack of understanding of the other business. Other than general cultural and organisational differences, problems related to risk allocation, data privacy and capital management pose particular threats to any potential collaboration on InfraTech. What is needed is for the government to facilitate collaborations by building common platforms and smoothing out the process of partnerships through expert guidance and provision of mediators wherever needed.

INVESTOR PERSPECTIVE

By enabling industry and governments to do 'more with less' InfraTech not only has the potential to increase the attractiveness of assets to private capital, it also enables cost-effective upgrades of existing infrastructure, extends asset life and defers costly asset maintenance and renewals. Overall project risk is reduced by using data and analytics to make better, more informed decisions across the value chain. In reducing or better-quantifying risks and costs, infrastructure investment becomes more attractive to private capital, helping reduce the burden on government budgets.

According to a report by the BPF, over 50 per cent of InfraTech seeks to solve sales and leasing issues, while only 16 percent and 12 percent respectively apply themselves in construction and investment/financing respectively. Land acquisition and refurbishment has less than 5 percent of active InfraTech companies. This demonstrates that there is a big gap to be filled and huge gains to be made by bringing technological innovation to construction. In the last few years there has been a significant increase in venture capitalists funding startups seeking to disrupt the construction industry.[5]

While investments are coming in, the driving factor for such investments is technological firms' role in InfraTech collaboration. It is thus easier for technology firms to get the funds for venturing into the construction industry than owners of infrastructure businesses to get investments for digitising their business. Investors are keen to back projects in which technology providers play a leadership role as consortium members, rather than simply as sub-contractors passively supplying technology to order. In a survey conducted by MergerMarket a decisive majority (87 percent) of investors say they would be more likely to back a bid in which the technology provider is a member of the consortium. This includes 20 percent who say they would be significantly more likely to back such a bid.[t]

The government stands to play an important role in furthering investments into the InfraTech sector by formulating favorable policies mediating deals especially between long functioning infrastructure firms seeking to digitize business and private investors willing to fund the disruption.

5.   https://medium.com/@OROCON_PRIME/what-is-contech-afaa8943691
6.   https://www.mergermarket.com/assets/Pinsents_Infratech_Report_Text_FINAL_LR.pdf

BARRIERS TO INFRATECH DEVELOPMENT

In late 2019, the Global Infrastructure Hub (GI Hub) conducted a survey of over 400 infrastructure practitioners globally,[7] revealing that top of the issues industry felt least prepared to deal with was sustainability and geopolitical challenges such as the rise of climate change, natural disasters and increased social inequality. The survey results also showed that technology-related trends or InfraTech (specifically the rise of the Internet of Things, sensors and smart infrastructure) were perceived to have the highest impact on the industry.

However, transforming from one of the least digitised industries to a leader in utilising innovative technology is not going to happen overnight. Construction companies themselves often lack the necessary resources to introduce InfraTech products and solutions into their systems effectively, delaying the time it takes to see the benefits of the technology on an industry-wide scale.

There is a concern amongst industry players that digitising physical assets may lead to extra risk. Extensive use of any technology makes a business vulnerable to cyber threats and data privacy issues. Artificial Intelligence systems that are prone to errors, subject to bias, or easily hacked can expose an organization to public criticism, as the government of Australia recently discovered when they implemented an algorithm that was designed to detect welfare fraud. Flaws in the algorithm caused thousands of welfare recipients to receive false debt notices. This eventually led to a large public outcry and an official investigation by the Australian Senate.[8] Lack of technological and legal preventive measures against such flaws in

technology hinder the spread of it in construction businesses which have primarily run on physical labour for a long time.

There is also an education barrier that exists in the infrastructure workforce in terms of understanding the benefits of digitization and how to use them. A paradigm shift to tech friendly workforce or technology training of existing forces are needed if technology has to be integrated into the business. An associated factor is the lack of commitment of the private sector towards investing in R&D in fear of no adoption or payback and thus the construction sector generally doesn't innovate as prolifically as possible. Construction isn't aided by its cyclical nature. Contractors are often either pressed to complete multiple projects at the same time, or are in between. The stress or lack of ongoing revenue entering the business can make implementing tech solutions a challenge. Altogether, there are few incentives to adopt innovative digital use cases in infrastructure.

InfraTech forces companies to adopt new ways of doing business. New business styles cripple existing business structures, creating problems for teams that are used to a certain way of working. Cultural differences can cause issues if not dealt with correctly. Agreeing to data requirement demands comes out as the biggest concern here. Two or more firms coming together, particularly under the technology umbrella, require clear guidelines on data sharing and tech firms especially have several limitations regarding this which are often unacceptable for infrastructure firms.

7. https://www.gihub.org/blog/what-is-infratech-and-why-is-it-important/
8. https://www.resolver.com/blog/risks-disruptive-innovation-technology/

PART 2: FOSTERING INNOVATION

ENERGY

India is the third-largest producer and fourth largest consumer of electricity in the world. As usage increases with the electrification of transportation and increased demand from the manufacturing sector, India is planning to realize its vision of adding nearly 225GW of renewable energy to the power grid by 2027, to add to the current capacity of 383 GW.[9]

Some of the major global trends include renewable energy, blockchain, energy-as-a-service, energy storage technologies, quantum computing and vehicles to the grid[10]. In particular, the field of solar energy is undergoing many innovations and discoveries. Photovoltaics (PV) and concentrated solar power (CSP) are two major technologies dominating the field.[11]

Blockchain is a major field that is gaining traction – it allows energy companies to validate transactions quicker and maintain records for huge quantities of data. In the near future, the main impact area for blockchain technology is in the fast-growing microgrid segment and off-grid rural areas in India. Policy makers have envisaged two main use cases of blockchain for the energy sector – facilitating energy trading by implementing smart PPAs (Purchase Power Agreements), smart microgrids, REC Certificates Issuance, etc and battery swapping infrastructure for the e-mobility segment.[12] Australian startup Power Ledger has partnered with Tata Power and India Smart Grid Forum to launch a first-of-its-kind peer-to-peer solar energy trading project in Delhi which uses blockchain technology to cut out the middlemen and allow prosumers to deal directly with each other.[13]

In the last few years, many energy startups globally have been innovating in the energy space to reduce the use of natural resources. In India, some of the major energy startups include ReNew Power, Bounce, Avaada Energy, Repos Energy, Flutura, Mysun, Oorjan amongst others.

9. https://www.tdworld.com/overhead-transmission/article/20972525/indian-power-sector-a-hub-of-innovation
10. https://www.startus-insights.com/innovators-guide/top-10-energy-industry-trends-innovations-in-2021/
11. https://energy.economictimes.indiatimes.com/energy-speak/six-innovations-and-technologies-disrupting-the-solar-power-industry/3786
12. https://nextrendsasia.org/blockchain-a-hype-or-a-game-changer-in-indias-energy-sector/
13. https://www.smart-energy.com/renewable-energy/tata-power-unveils-blockchain-enabled-solar-trading-for-delhi-customers/

To boost the investment in the energy space, which saw a decline in 2020 due to the pandemic, a not-for-profit network of technology and business incubators that manages India's Clean Energy International Incubator Centre (CEIIC) announced a new initiative to seek out innovators who address critical but undervalued innovation gaps.[14] Since its incubation in 2018, CEIIC has already incubated 25 startups. The latest initiative also focusses on addressing issues created by the COVID-19 pandemic as it seeks to target technologies that both improve livelihood and positively affect climate change.

India's keen focus on energy innovations has also attracted investment from all over the world. In 2015, the renewables industry started pushing for more climate-compatible growth by aggressively ramping up capacity, at an annual growth rate of 17.5% in the period from 2014 and 2019. This was done in response to the government's intent to transition to a lower-emission electricity system explicit by declaring an ambitious target of 175 GW from renewables by 2022.

A. GRAM POWER

Urban power infrastructure is facing many issues nowadays. Among them are distribution losses, outages and the lack of quick data communication. IoT technologies convert municipal energy utilities into the Internet-of-Energy, a networked system of smart generation grids, real-time load management, energy metering, and automated distribution. It aspires to streamline the urban energy information and make it available across all links involved.

Gram Power from India produces smart energy metering and grid management software for making urban and rural areas smarter. It provides a digital mapping of energy distribution networks, remote 'metering as a service', and consumer mobile application for budget monitoring, bills, and theft reporting, in order to achieve more energy-efficient consumption.

B. FUTURESISENS

As natural gas is still widely used for heating and cooking purposes, gas infrastructure retrofitting appears to be a good solution given the fact of depreciation and climate change challenges. Smart sensing and metering of gas pipes enable cost-saving, regular condition and theft monitoring, and consumer engagement, to provide a more transparent setting for gas distribution and consumption.

Spain-based FutureSiSens designs and manufactures thermoelectric microsensors based on nano-silicon technology. These microdevices detect very small-scale gas flow variations while maintaining zero-power consumption, real-time gas monitoring, and wireless networks integration.
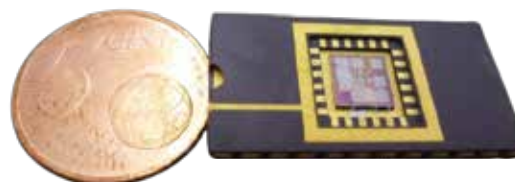
ROADS AND RAILWAYS

Indian Railways manages the 4th largest railway network in the world. It transports almost 23 million people daily and over the past few years, has been steadily investing in technological solutions that make rail travel in India cleaner, safer, and more comfortable. The Indian Railways is investing in state-of-the-art Video Management Systems (VMS) to provide a safer experience for passengers transiting through railway stations. The Government of India has also approved an INR 25,000 Cr project which will provide 5MHz 4G connectivity to the national carrier.[15] This would enable several innovations including an IoT based remote asset monitoring and a Collusion Avoidance system (ACAS), increased line capacity with existing infrastructure and would also allow better communication between locomotive pilots and guards.

In the private sector, a Bangalore based startup is also piloting smart technologies which accurately collect information such as equipment temperatures and relay it to intelligent braking systems. A slew of start-ups such as Confirmtkt and RailRestro have contributed to making a train journey smoother all the way from ticket booking to the travel itself. As the world moves towards smart highways, the Indian highway network also holds tremendous promise for innovations that seek to make construction cheaper and better. Significant breakthroughs in material technology such as the use of steel fibers and iron oxide nanoparticles are making highways more resistant to wear and tear.

Futuristic technology is also helping soothe congestion in densely populated cities. Alibaba's AI-based traffic management system, City Brain, which uses real-time GPS data and data from cameras at various intersections to coordinate traffic signals has been deployed across 23 cities in China, giving us a glimpse of the potential of these technologies to improve the quality of life in our cities.

15. https://www.ndtv.com/business/indian-railways-allotted-with-5mhz-spectrum-cabinet-approves-5mhz-4g-spectrum-for-rail-operations-investment-estimated-over-rs-25-000-crore-2459973

A. EASYMILE

EasyMile is a French company that provides software solutions for driverless mobility and autonomous technology. One of its products, the EasyMile EZ10 Shuttle uses LiDAR sensors and GPS to sense the environment on a road and devise strategies to get through the traffic and other external factors. The driverless shuttle holds up to 15 people at a time, and it only goes up to 12 miles per hour, which is in everyone's safety interests. It is completely electric, can navigate segmented roads, as well as roads that have slow-moving automobiles on it. A step-by-step approach has been provided at the core of EasyMile's software, which has been validated through a zero-collision record.

B. RAILPOD

RailPod, based out of Boston, is a startup that works towards making global rail infrastructure safer, more cost-effective and efficient. This is done through the use of automated inspection drones, which perform daily track inspections with the help of advanced sensor technology and a cloud-based data processing service.

It provides real-time information to operators about track conditions. Its inspection tool can be configured for autonomous applications as well as be operated with a wireless remote control. The vehicle, coupled with its web-based software gives immediate access to inspection reports, including data on track geometry, rail wear, overhead catenary, asset mapping, and broken rail detection. Using its drones for an inspection significantly reduces the risk, time, and cost of accessing remote areas.

WATER AND SANITATION

Water security is one of the great challenges that humankind faces in the 21st century. In the face of these challenges that are fuelled by rapid urbanisation and climate change, governments in developing nations are turning to sustainable solutions that allow the safe sourcing, treatment, distribution, usage and reusage of water.

McKinsey predicts that India's urban agglomerations will be home to 590 million people by the year 2030[16]. This would obviously put tremendous strain on water sources in these areas. India's cities are teaming up with innovative start-ups to combat these challenges. Fluid Robotics, a Pune based start-up is pioneering the use of robots and drones to conduct surveillance of a city's wastewater infrastructure. Similarly, other start-ups are using IoT and AI based systems to detect, purify and distribute water through water ATMs.

In the Middle East, cities like Dubai are piloting decentralised wastewater management systems that use sensors to monitor the quality of the treated water. This technology could prove to be an effective alternative to the expensive, centralised systems in use today across most major cities.

16. https://www.mckinsey.com/featured-insights/urbanization/urban-awakening-in-india

Similiarly, during the COVID pandemic, the innovation of new Automated Waste Collection Systems (AWCS) has increased significantly. In Finland, a company called MariMatic Oy is pioneering pneumatic systems which allow contactless garbage collect through a series of collection points with automatic doors which route recyclable and non-recyclable waste through a network of tunnels via vacuum and airflow to a common collection point for disposal or recycling.

The Government of India is also moving to improve the nation's sanitation infrastructure, and through the National Infrastructure Pipeline, plans to invest in over 1342 projects worth over ₹21.51 lakh crores.[17] The Jal Jeevan Mission was instituted with the aim of providing all rural households access to safe and adequate drinking water by the year 2024.

With an innovative cohort of start-ups, backed strongly by the Indian governmental agencies and global non-profits, India is projected to be leader in Water Supply and Sanitation (WSS) solutions in the years to come.

17. https://www.nbmcw.com/news/govt-lists-111-lakh-cr-infra-projects-under-nip.html

A. AQUA ROBUR

The growing weaknesses of traditional municipal water supply in the digital era such as aging pipelines and valves, costly diagnostics and repair, maladaptive management of leakages and theft, pose a question of upgrading built water infrastructure to cyber-physical water networks. Usually, this is achieved by incorporating smart water meters and valves, sensor-equipped pipelines, remote diagnostics tools, leakage prediction instruments, and smart analytics.

The Swedish company Aqua Robur develops FenixHub, a self-powered IoT device, capable of measuring and collecting data to discover leaks and deficient water quality in municipal pipelines. FenixHub addresses the questions of adequate energy supply and wireless integration by employing hydro-based energy harvester with Long-Range and Narrow-Band Internet of Things (LoRa & NB-IoT) functionalities.

B. WEGOT UTILITY SOLUTIONS

With the novel coronavirus confining almost everyone to their homes, the use of electricity and water has shot up. But as climate change alters weather patterns and endangers water supply across the world, it's imperative to use the same judiciously and conserve the precious resource.

Chennai-based water management startup, WEGoT Utility Solutions aims to do that and put India at the forefront of water conservation. The startup uses its proprietary IoT device and software to help cut down the demand for water by more than 50 percent, by detecting drop leakages and water theft, and informing the user in real time. The IoT-based device and software platform can be connected to water inlet pipes to monitor water consumption. The solution is certified by the Fluid Control Research Institute (FCRI) as having more than 98 percent accuracy rate.

EDUCATION

We have seen an explosion of capital infusion into the ed-tech sector in India and also, a progressive growth in investments being made in the school infrastructure across the nation. From 2016-2020, the smart classroom market in India grew at a CAGR of 23.44 per cent.[18] The Digital India initiative has proven to be a significant contributor to this growth. As internet connectivity improves across India, the government is working on an ambitious proposal to upgrade 1.3 million classrooms with smart infrastructure.

Smart classrooms require various components such as learning products, hardware and software. Digital whiteboards, projectors and computers make up the hardware component of smart classrooms. Smart classrooms have been shown to improve learning outcomes for students and also make the job of a teacher easier, by incorporating audio-visual content into their teaching. A survey by Gallop concluded that smart classrooms increase student engagement and participation by up to 55 per cent. Several state governments including Karnataka and Haryana have committed to adding thousands of smart classrooms in state-run schools. Samsung, through its Samsung Smart School Initiative is upgrading over 800 classrooms across the country impacting over five lakh children.

Indian startups such as Next Education have stepped in with software solutions and learning management systems that help schools track student progress and help in curriculum planning. The adoption of Learning Management Systems (LMS) has skyrocketed due to COVID pandemic which made remote learning a necessity. It also exposed a vast gap between the infrastructure of large private institutions and that of small schools and also several government run institutions. Learning outcomes were affected among underprivileged students of all age groups. India's Edtech giants and the central and state governments working in tandem is certain to ensure a bright future for India's students and create an equitable educational experience across the socio-economic spectrum.

18. https://www.researchandmarkets.com/reports/3802160/smart-classroom-market-in-india-2016-2020

A. BYJU'S

BYJU'S is India's largest ed-tech company and the creator of a school learning app which offers highly adaptive, engaging and effective learning programs for students in LKG, UKG, classes 1 -12 (K-12) and competitive exams like JEE, NEET and UPSC. They launched their flagship product, BYJU'S - The Learning App, for classes 4-12 in 2015. Today, the app has over 75 million registered students and 5.2 million annual paid subscriptions. An average time of 71 minutes is being spent by a student on the app every day from 1700+ cities. With its most recent acquisition of White Hat Jr, the platform is also empowering children with coding skills. BYJU'S is paving the way for new-age, geography-agnostic learning tools that sit at the cross-section of mobile, interactive content and personalised learning methodologies.

B. CLASSPLUS
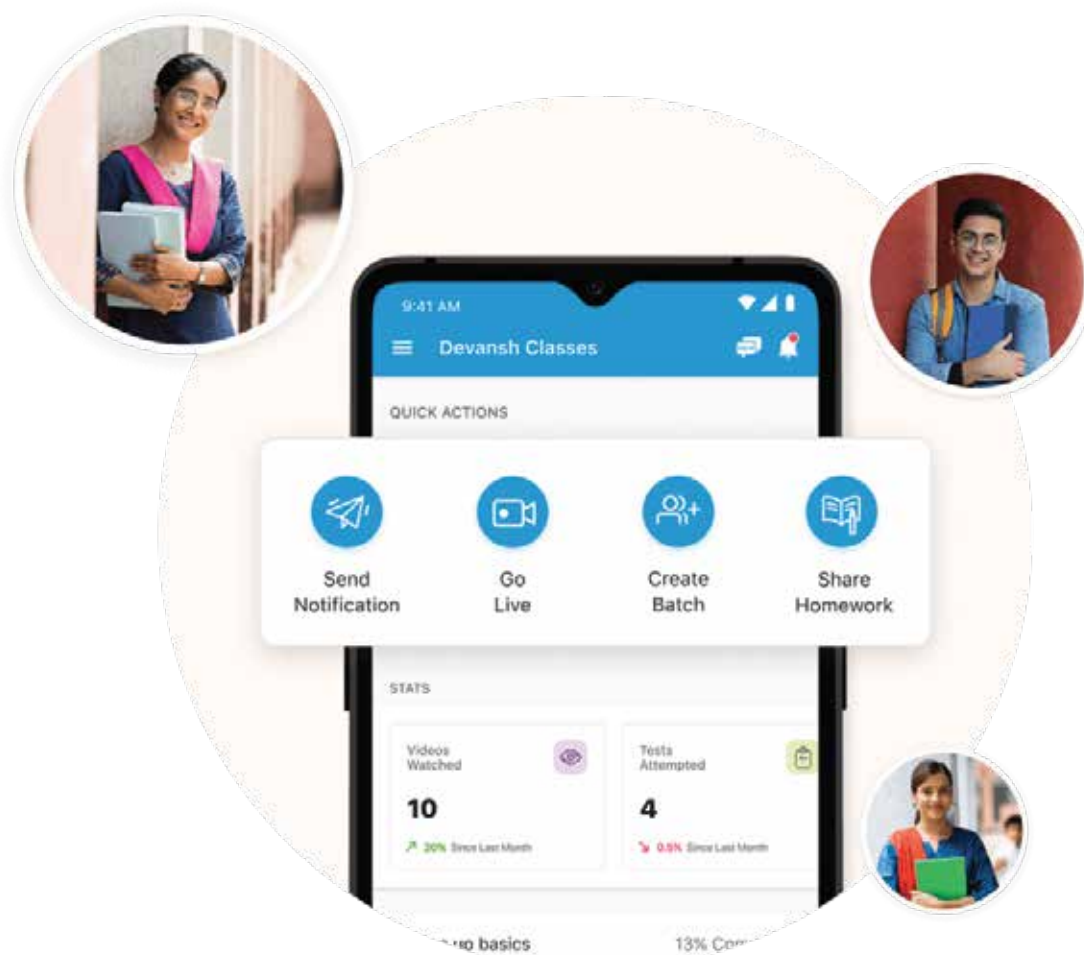
This Delhi-based startup is a mobile-based SaaS platform to help private tutors and coaching centers take their brick-and-mortar set-ups online. Classplus empowers teachers through a mobile-first product that allows them to share messages, assignments, online tests, and video lectures with their online students. Offering useful features such as fee management of students, performance tracking and test reports, and live chat with the tutor, among others, the app has three different modes for tutors, students, and parents. With digital payments and ease of tutoring, Classplus today has a base of 1,00,000+ tutors across 1,500 cities serving 12 million students.

AGRICULTURE AND FARMERS' WELFARE

The post-harvest wastage related losses of Indian farmers run into the tens of billions of dollars according to ASSOCHAM. In a country where a 82% of all farmers are small and marginal, a new wave of agro-tech start-ups are mobilising to make the average Indian farmer more productive and more profitable.

While it is true that a majority of the agro-tech start-ups in India focus on pre-harvest support such as drone technology for spraying pesticides, automated irrigation and satellite-based weather prediction technologies, there are start-ups which are helping farmers with storage, logistics and demand prediction.

Start-ups such as Arya, are driving the digitisation of warehouses and cold storage infrastructure and enabling farmers to get their produce to storage and the markets rapidly. With new digital ERP solutions, farmers are able to sell their produce directly from the warehouses and also avail credit against their stored produce. Other companies are deploying powerful ERP solutions that use AI and data science to aid farmers and agri-start-ups in mapping

supply with demand, which is often critical to ensure minimum wastage.

Start-ups are also exploring other means of farming such as hydroponics, or soilless farming. In Ahmedabad, Rise Hydroponics is driving the adoption of this technology by providing end to end soilless farming solutions that enable farmers to profitably grow crops in controlled environments, all year round.

At the height of the COVID-19 pandemic, farmers in the villages of Kovur and Vidavaluru used drones to spray pesticides in their fields. This helped the farmers mitigate the effects of the labour shortage felt during the pandemic. The drone usage led to a 30% reduction in pesticide costs.[19] These benefits indicate that these innovations are here to stay.

With the agricultural sector receiving increased attention from the corporate and VC sectors, the Indian agri-tech sector is certain to contribute greatly to the increased productivity and efficiency of Indian farmers.

19. https://www.newindianexpress.com/states/andhra-pradesh/2021/aug/02/how-tech-helps-nellore-ryots-overcome-labour-shortage-due-to-covid-2338915.html

A. KRISHITANTRA

Krishitantra, a Hyderabad based startup, provides rapid IoT-based soil testing and soil nutrition advisory solutions to farmers, farmer producer organisations (FPOs), and agribusiness stakeholders. It has developed a highly portable IoT device branded as Krishi RASTAA, that generates soil test results within 30 minutes, precisely analysing macronutrients, micronutrients, pH, organic carbon, EC, and microbial counts. Based on the soil test results, crop-specific soil nutrition recommendations are automatically generated and sent to farmers. The company aims to optimize fertilizer application for farmers, increasing crop yields, reducing the cost of cultivation and improving soil health. Additionally, the company believes it can have a major impact reducing GHG emissions while promoting sustainable agriculture and soil conservation.

B. AUGMENTA

Currently, there is a demand for easy-to-use, low-cost, reliable solutions that allow farmers to treat their farms according to their actual needs, in terms of irrigation and fertilizers. Augmenta, a Finland based startup, helps farmers understand the quality and health of their crops via a plug and play device that scans and analyzes crops as a tractor moves across the field capturing video data of every inch of the field. It also automates tasks such as fertilizer application, through crop-calibrated software. By utilising instant image processing and artificial intelligence, the system decides on the amount of farm inputs (such as fertilizers) that every inch of the field actually needs and immediately applies it by controlling the rate of sprayer or spreader application, through various machinery communication protocols. The tool has already been installed and tested in eight countries and used on more than 26 thousand acres. A conducted study demonstrated that the 'Field Analyser' brings 12 percent increase in yield, using 13 percent fewer chemicals and producing a 15 percent improvement in protein levels.

FOOD PROCESSING

The Indian food processing sector was valued at US$ 328bn in 2018 and is expected to reach US$ 535bn by 2026. India-based start-ups have driven this growth in the food processing industry in the past five years. ~30 percent of the overall food start-ups in India are accounted by Food Processing Companies.[20]

The COVID-19 pandemic has created an urgency in the demand for packaged foods and drinks. This has further increased the demand for innovative technologies in the food packaging space. There is a rising interest in High-Pressure Processing as a food-preservation mechanism.[21] Another popular technology is Individual Quick Freezing that has been introduced by several domestic companies as demand for natural products grows. Some other techniques are vacuum drying, freeze-drying and sugar reduction.

Another area of interest for the food processing industry is the storage sector. Globally, approximately 1.3bn tons of food is lost or wasted every year.[22] In developing countries, of the main reasons for this is the inability of farmers and retailers to store agricultural produce. There is a lack of good cold-chain infrastructure. Additionally, the rise in temperatures due to global warming is making it even more difficult for hot countries to store their food. One solution that addresses both these issues is to create alternative cold storage options that use renewable energy sources. An innovation that does that is ColdHubs, a startup that has developed a 'plug-and-play modular assembled walk-in cold room' that uses solar energy to power its cooling systems.[23]

In India, with the second lockdown, vendors have been struggling with their produce as they are unable to reach customers. Storage has been a major issue with one of the frequent problems being that of

20. https://www.indiaretailing.com/2020/04/23/food/food-service/technology-trends-that-will-shape-indias-food-processing-industry-in-the-post-covid-world/
21. https://www.indiaretailing.com/2020/04/23/food/food-service/technology-trends-that-will-shape-indias-food-processing-industry-in-the-post-covid-world/
22. http://www.fao.org/food-loss-and-food-waste/flw-data)#:~:text=One%2Dthird%20of%20food%20produced,way%20to%20final%20household%20consumption.
23. https://gca.org/why-sustainable-food-systems-need-cold-storage-innovations/

moisture in grains. To solve these issues, multiple startups like Intellolabs and AgNext have come up with innovative solutions for real-time quality testing to help prevent wastage. AgNext offers instant and on-field physical, chemical and ambient assessments for food safety, quality, and security from farm to store through its Artificial Intelligence (AI) platform Qualix. The company is also currently testing a low-cost storage solution.[24]

Indian farming is hampered by an outdated and inefficacious supply infrastructure that leads to the wastage of at least 25-30 percent of fresh produce, despite India's agricultural diversity. Silicon-valley backed startup, Superplum is another example of startups that use innovative techniques to solve storage problems in the food industry. Instead of storing produce in farms or one place, they have ensured that their entire transport system is refrigerated, right up to the distribution level. Superplum's low-cost cold-chain transport solution controls high-temperatures, humidity, and ethylene levels of fresh produce, by automatically adjusting to ideal settings depending on the fruits being carried from point A to point B.[25]

These startups are using data science for quality supervision and prediction models and other advanced technologies like IoT. Superplum's cloud-based management system uses technology to give its consumers food safety and information on pesticide quality through the brand's app. This also enables shoppers to cross-check lab test reports, the temperature the fruit was transported at, and farm-level quality parameters.

24. https://www.thehindu.com/sci-tech/agriculture/agri-tech-startups-sensors-storage- fresh-food-supply-value-chain-india-lockdown-prevent-waste/article34654928.ece
25. https://news.mysmartbazaar.com/produce-wastage-during-the-lockdowns- sees-startups-mobilising-to-aid-farmers-and-vendors/

A. INTELLO LABS

Gurugram-based Intello Labs taps the power of AI, ML, and computer vision to solve one of the biggest problems our world faces – cutting down food loss. They do so by digitizing the quality assessment of fresh fruits and vegetables. The startup's flagship Intello Track app offers mobility and remote access from a single source of operation, and provides relevant quality statistics (such as colour, size, and visual appearance) to growers in real-time, to reduce the chances of wastage. So, taking a picture of a single fruit or vegetable generates data on whether it is under-ripe, ready to consume, or damaged. Their AI-based products help with quality grading, sorting and packing at various points in the supply chains, from the farm all the way down to retail stores. While the products can be deployed as point solutions, the system's — mainly Intello Track's — effectiveness increases manifold if all the players in a single supply chain use it together.

B. PROMETHEAN POWER SYSTEMS

Promethean Power Systems designs and manufactures innovative refrigeration systems for cold-storage and milk chilling applications in off-grid and partially electrified areas of developing countries (India, Bangladesh, and Sri Lanka). They solve the problem of unreliable electricity in rural India by converting and storing electrical energy into patented thermal batteries, thereby eliminating the need for backup diesel generators. This addresses problems of dairy processors, who incur up to 20% of their costs in retrieving unrefrigerated milk from villages twice a day before it spoils. Consistent cooling provided to milk arrests and avoids bacterial buildup and thus prevents wastage. Unlike conventional bulk chillers, Promethean also offers portable bulk milk chillers which are truck mountable too and can be moved/shifted.

CIVIL AVIATION

Over the past decade, India has been one of the most rapidly growing aviation markets in the world and is poised to become the third-largest by the year 2024. Through FY16-FY20, domestic aircraft movements grew at a CAGR of 9.83 percent and passenger traffic in the financial year 2020 stood at 341 million.[26] Robust demand and sound domestic policies have been significant factors in this growth story.

Throughout the duration of the pandemic, innovation in the aviation space has continued to boom. All around the world, airports have used this time to revamp a whole host of passenger services, while managing to incorporate newer and higher standards of security and hygiene. With IATA projecting a 88 percent revival in the air traffic by the first half of 2021, flyers can expect to be welcomed with much improved boarding and flying experiences.

Airlines and airport management are working harder than ever on eliminating queues and bottlenecks by adopting an array of new technologies including electronic baggage tags, sensor enabled wearable tech and touchless check-ins. In the wake of the COVID-19 pandemic, the Norwegian airport operator, Avinor, has rolled out contactless experiences at 7 of Norway's hub airports.[27] New technology is also impacting the cargo business with major freight players including DHL and Lufthansa Cargo swiftly moving to adopt IoT technology to track shipments and even gather temperature data in cases of sensitive cargo. These technologies are enabling the global transport of life saving vaccines and helping speed up economic recovery.

Automation and robotics promise to eliminate outdated processes and usher in an era of progress at airports globally. These innovations are enabling airports to serve additional passenger and cargo traffic without having to expand space or deploy additional resources. Airports in major Indian cities such as Bengaluru and Hyderabad has made significant strides in meeting their power needs through solar and other renewable energy sources, proving once again that the goals of growth and sustainability are not incompatible with each other.

26. https://www.ibef.org/industry/indian-aviation.aspx
27. https://globetrender.com/2020/07/08/innovations-coronavirus-flying-air-travel-safety/

A. UNICOAERO – AIRPORT ROBOTICS SOLUTIONS

A big hurdle in airport management is management of passengers' baggage. Higher the passenger flow greater will be the baggage, adding to the burden on logistics.

The USA-based startup, Unicoaero, is a baggage technology platform providing mishandled baggage management solutions for airlines and couriers. The startup plans to bridge the information gap between airlines, ground service companies, and baggage delivery services through end-to-end baggage tracking and its delivery platform. The platform can also be used by airlines to introduce door-to-door baggage services to allow passengers to have baggage-free travel.

Driver App

Unicoaero Driver App automates order assignment, pick-up, tracking and delivery. No more paperwork, no lost vouchers. Driver App makes the driver's life easy!
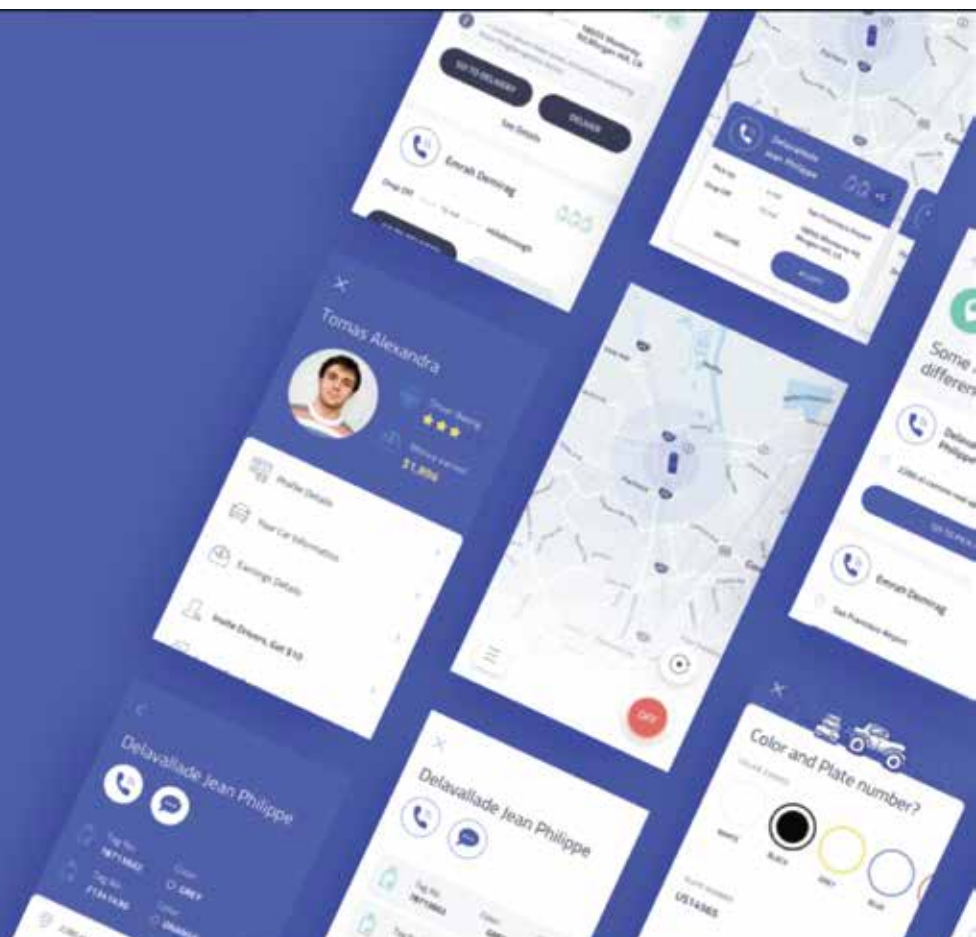
B. ZESTIOT – ASSET TRACKING & PASSENGER MANAGEMENT

The civil aviation industry is witnessing a fast-paced growth trajectory in India since the last three years. The country has become the third largest domestic aviation market globally and is expected to become the third largest air passenger market by 2024. With an increased passenger flow, airports need to be equipped with technology to better manage the traffic on the ground.

The India-based startup, ZestIoT, is using IoT and AI to provide solutions that can be used for asset tracking and passenger management applications. The sensors can track an aircraft when it is 200 nautical miles away, allowing the authorities to create awareness in and around the airport in terms of the aircraft and the traffic movement. ZestIoT helps the system make

predictions based on the congestion, airport environment, and capture data and insights for analysis. The startup offers various products, including AviLeap (improving OTPs for better real-time visibility and discovering blind spots), AviTag (enhancing asset/baggage tracking and inventory management), AviQ (improving passenger movement and reducing wait time), and AviX (enabling contactless boarding).

CONNECTED IOT PLATFORM

Improve OTP	Contactless Boarding	Queue Optimization	Baggage Tracking
AviLeap	AviX	AviQ	AviTag
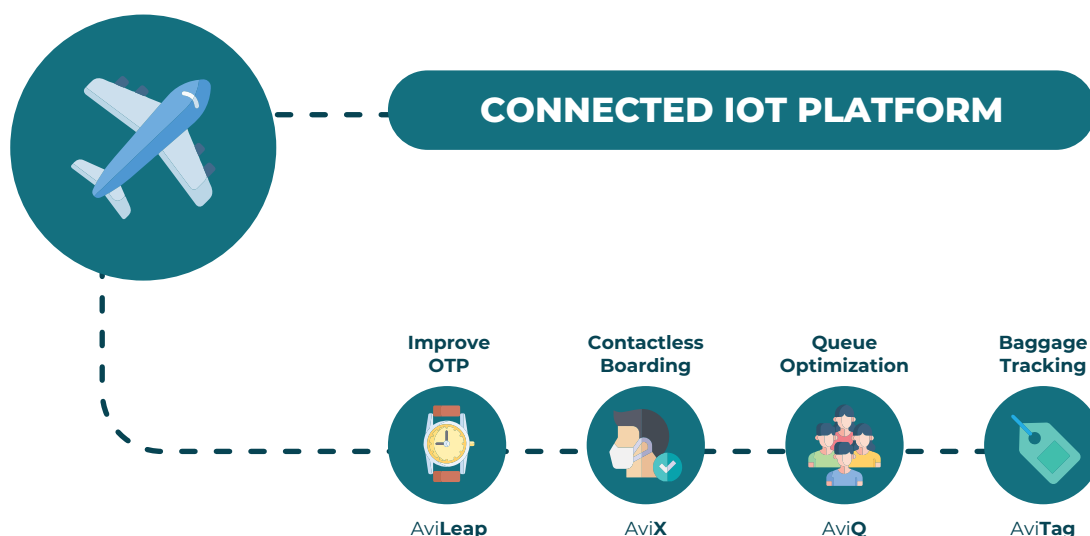
TRAVEL AND TOURISM

The COVID pandemic saw the global tourism industry take a significant revenue hit. International tourist arrivals globally dropped, on an average, 70 percent.[28] With the pandemic and subsequent global lockdowns forcing India to suspend the issuance of tourist visas, and domestic lockdowns preventing long distance travel, India's tourism industry is currently in a very precarious position.

However, as countries such as France, Italy and New Zealand slowly reopen for international tourists, there are significant learnings for the sector. Pent up demand and the fact the lockdowns have resulted in saving and disposable incomes at new peaks, show all the signs of a tourism boom once travel restrictions are lifted. Here is where technology can step in to ensure that key tourism industry stakeholders are able to provide patrons with a sense of security. The vaccine passport is one such initiative. The Indian government through the CoWin app has made it very simple and straightforward to obtain one's certificate upon vaccination. This initiative is bound to help boost customer confidence in the security measures taken.

Hotels are also exploring new touch-free experiences. Vouch, a Singaporean start-up which makes digital concierge bots for hotels and other venues has reported a vast increase in orders since the start of the pandemic. Using NFC technology and mobile applications, patrons can make bookings, place orders and requests, completely negating the need for staff interactions. In the same vein, hotels in European cities such as Dublin and Amsterdam have unveiled contactless check-in kiosks, where patrons can scan their passports and obtain key cards with zero staff intervention.

In India, the recently established industry association, Confederation of Hospitality, Technology and Tourism Industry (CHAAT), promises to speed up collaboration between hoteliers and India's tech companies and increase product advocacy and adoption. This collaboration could very well become a key factor in the rebound of the tourism sector.

28. https://www.weforum.org/agenda/2021/05/covid-19-travel-tourism-virtual-reality/

A. QUANTELA – CROWD MANAGEMENT SOLUTIONS

Cities with large tourism activity usually organise big events to bring a positive message and create awareness about various issues. However, these big events require efficient crowd management as throngs of people attend them. This is becoming easier with advancements in the fields of IoT sensors, Big Data, and Artificial Intelligence. Together, these technologies help identify, locate, and take measures to control crowds and prevent potential risks. The USA-based startup, Quantela, specialises in smart city solutions using IoT and AI. They are developing crowd management solutions that analyse sensor data from across entry and exit points and monitor traffic to orchestrate movement of the crowds and facilitate preventive measures as required.

B. FLIPPARGO

To encourage tourism and showcase their traditional heritage, cities go to vast lengths to showcase and curate their scenic spots and other centres of attraction. This can be simplified with the use of Augmented Reality (AR) by allowing them to display all tourist attractions in one place, and help them plan their trip more efficiently. AR can help enhance information on historical sights, interactive tours, and other relevant information through an immersive experience.

The India-based startup, FlippARGo, focuses on creating AR experiences for tourists across the globe with the aim to promote various arts and crafts conferences, museums, and other places within India and abroad. These experiences are available to tourists through FlippARGo's proprietary iOS and Android applications.

SHIPPING AND MARITIME

India's maritime sector is a pivotal component of the Indian economy, accounting for 95% of EXIM trade by volume and a significant employment generator. India also plays a key role in global maritime trade accounting for 1.05% of global coastline and accounting for 10.4% of global maritime trade in FY 2019. India is an integral part of the shipping ecosystem, contributing to 9.03% of the total seafarers (officers) globally. India is also a major provider of Ship recycling accounting for 27.23% in terms of Gross Tonnage (GT).

To boost investment in the sector, a National Logistics Portal (Marine) is being planned as a single integrated platform for all EXIM stakeholders enabling 100% paperless processes. The portal will enable multiple e-facilities like domestic shipment tracking, cloud-based document management, digital payments etc. Additionally, 50+ smart interventions such as predictive maintenance and deployment of automated quay cranes have been identified to transform major ports into smart ports.

During the COVID-19 pandemic, several digital initiatives[29] were developed to maintain smooth functioning in the maritime industry without human interference, such as:

a. E-office for internal use; E-invoice, E-payment, E-DO, and E-BoL at PCS1x

b. Utility for Sign-on & sign-off (E-pass module)

c. Utility for data verification of seafarers from chartered flights

d. Maritime Training: E-learning, virtual classes, online exit exams

e. Online ship Registrations & online charter licensing.

29. https://www.marineinsight.com/shipping-news/india-year-end-shipping-sector-review-various-efforts-and-initiatives-to-mitigate-impacts-of-pandemic/

Some ports have adopted digital technologies to boost port infrastructures. The Krishnapatnam Port Company Limited (KPCL) announced the 'Rapiscan Eagle P60' which is a drive-through x-ray container scanner & radiation portal monitor that enhances the terminal's performance while increasing security and safety of the port. The container scanner will radically enhance the terminal's overall performance while reducing the total service time.[30] The Jawaharlal Nehru Port Trust (JNPT) has also worked on an innovative transport solution to achieve faster and more movement of cargo from the port to respective destinations through Direct Port Delivery (DPD). Because of this solution, an exporter or importer should now be able to book his cargo directly from his office, through a technology-backed platform.

Freightify, freight-tech logistics startup based out of Chennai is a front-runner in the encroachment by digital brokers on traditional freight forwarder markets. It has been digitizing the manual processes in forwarding and in a first-of-its-kind initiative across India, the Freightify platform was integrated with Maersk Spot to allow customers to book and secure container space online and in real-time. Cogoport, Shipwaves and FreightCrate Technologies, are some of the other most notable digital freight brokers in the country.[31]

In order to move towards a digitally enhanced global supply chain, large ports all over the world are using technological advancements. Hamburg, the third busiest port in Europe installed camera systems, sensors, and smart lights on roads to monitor traffic, alert users when a bridge is lifting, and smoothen the passage of working barges and other vessels during busy hours. Many countries like China are also building digital communication platforms to monitor all ports and their logistics platform in a single place. Some others are turning themselves into centres of innovation by conducting "hackathons" and inviting maritime-based startups from all over the world. The ulterior goal of carbon-neutral ports is also being targeted in the long term.[32]

30. https://www.itln.in/building-port-infrastructure-to-boost-indian-exports-logistics
31. https://www.joc.com/international-logistics/logistics-technology/indian-tech-start ups-target-traditional-forwarders_20191126.html
32. https://www.worldfinance.com/infrastructure-investment/dawn-of-the-smart-ports

A. SEAPORT SOLUTIONS

Port management usually involves multiple stakeholders working together in coordination with shipping companies to enable smoother operations that are efficient. But, unreliable data creates confusion and delays, and is expensive for all entities involved. SEAPort Solutions, a Spanish startup, optimises port call processes with a collaborative data exchange platform. Through the platform key stakeholders in port call processes including port authorities, mooring companies, tugboat companies, and terminal operators, get real-time visibility of data to enable seamless port functioning.

The platform also facilitates follow-ups of all events that are associated with port call processes. This directly results in optimised port operations as well as a substantial increase in productivity and effective utilization of resources for all key stakeholders.

B. MARINSPECTOR

Seafaring vessels require regular inspection, but it is not cost-effective to keep them at the dock for a considerable amount of time, every time an inspection is scheduled. Marinspector, a Turkish startup, has developed a remote ship inspection platform for the maritime industry. This platform enables higher efficiency, effectiveness, and accuracy in ship inspection processes across the board. Further, the solution enables inspectors to carry out their inspection in real-time. This is done through mobile device streaming and remote camera control. Additionally, the platform is encoded for bandwidth and latency optimization which assists the platform to adapt to the existing connection quality.
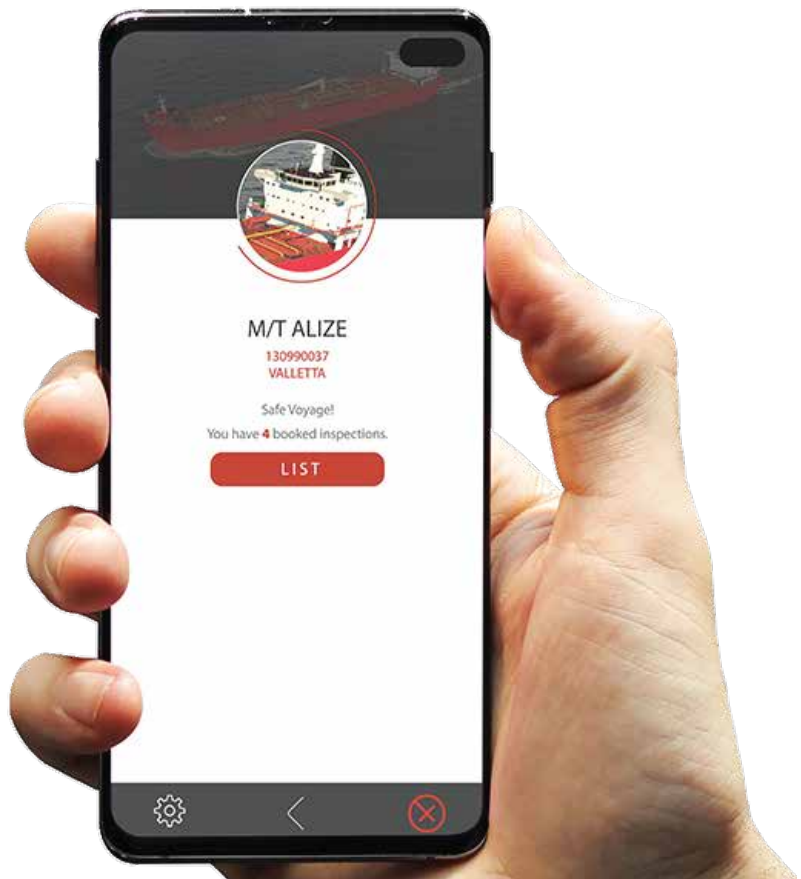
Remote Ship Inspection Platform & Tool

Marinspector provides a safe and reliable system, to perform inspections effectively, efficiently without any restrictions.

MEDICAL INFRASTRUCTURE

The Government of India's 'Make in India' initiative has been encouraging domestic manufacture of medical devices and helping reduce the prices that patients have to pay for products such as implants and stents, which in the past used to be imported. Currently, India is leaning towards a consumer-led health care system but there is a push for better infrastructure and digitization of medical facilities and operations. With India's middle-class growing at a fast pace and the increased use of the internet, demand for quality and affordable healthcare has picked up pace[33].

India imports over 75 per cent of medical devices, as most home-grown companies continue to focus on manufacturing low-cost commodity products such as bandages, patient monitors, test kits, syringes, and stainless-steel instruments.[34] One of the leading diagnostics companies in India, SRL Diagnostics launched 15 RT-PCR Labs in 2020 along with several new labs and 150+ collection centres and has made dramatic progress on the digital innovation front. SRL uses Artificial Intelligence tools such as the ChatBot in order to respond to simple queries such as rescheduling and order status and to automate and expand their customer support teams while maintaining proactive communication with customers/partners. This reduced the waiting times for patients and drove heavy traffic to the SRL mobile app and website.[35]

The COVID-19 pandemic has accelerated the demand for a more robust digital healthcare system in India and various digital solutions have emerged to harbour the country's response to the needs of the public. The Aarogya Setu app is being used to monitor cases in real-time while several other solutions have also come up for contact tracing, health monitoring through smart devices, and patient care through AI-enabled support. Even before the onset of COVID-19, the government had shown its intent to reinforce its healthcare access, delivery, and outcomes by effectively leveraging technology through the National Digital Health Mission (NDHM). As part of this, the government has planned to roll out initiatives such as the Electronic Medical Records (EMR), Health Facility Registry (HFR), Digi Doctor, Health ID among others to make healthcare in India more efficient, inclusive, accessible, affordable, and safe. Additionally, the Digital India program that was initiated in 2015 has given a boost to the digital infrastructure of the country. Some government initiatives such as the National Health Portal, e-Hospital and Integrated Health Information Platform (IHIP) have been instrumental in fuelling market growth.[36]

33. hhttps://yourstory.com/2018/01/healthtech-startups-india/amp
34. https://www.entrepreneur.com/article/339175
35. https://economictimes.indiatimes.com/industry/healthcare/bio`vtech/healthcare /technology-is-going-to-play-a-key-role-in-indias-roadmap-for-health-infrastructure-etilc-members /articleshow/81683674.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
35. https://www.theweek.in/news/health/2021/04/07/covid-19-becomes-enabler-and- accelerator-of-digital-health-adoption.html

Some of the most popular startups in the medical infrastructure space in India include PharmEasy and Mfine – while PharmEasy is India's largest healthcare delivery platform and covers every single pincode in India, Mfine is an AI-driven, on-demand healthcare platform that provides online consultations and connected care programs from the country's top hospitals. While the COVID-19 pandemic has put some pressure on the Indian healthcare system, hospitals and startups have been working on transforming their layouts and increase their focus on out-patient healthcare using digital tools. Government departments have also been using AI and big data tools to identify pandemic hotspots and spot cases early.

A. IMPLICITY – REMOTE CARING SOLUTIONS

Use of AI with remotely connected monitoring devices can allow medical practitioners to efficiently analyse data and improve patients' healthcare. This ensures ample data availability for remote doctors to prescribe proper treatment. Remote caring allows healthcare and medical attention to reach patients in inaccessible locations while requiring only a few doctors to monitor, diagnose, and suggest treatment.

The France-based startup, Implicity, works on a remote monitoring platform for patients with connected pacemakers and defibrillators. An AI-enabled module determines the criticality of each alert based on the medical history of the patient. The platform analyses and filters the data received from remote locations based on criticality, allowing the medical practitioners to focus on essential tasks.
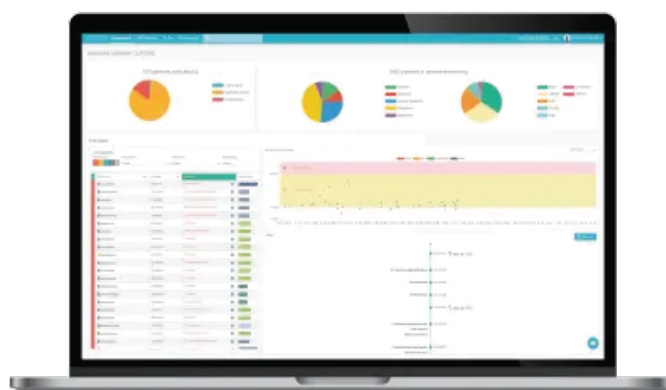
B. GLOCAL HEALTHCARE

A digital dispensary or 'a hospital in a box' is an innovative centre aiming to provide primary and emergency healthcare solutions from a single point. These centres function as an outpatient department with virtual consultation with doctors through video.

The India-based startup, Glocal Healthcare, has several tech-based solutions to make healthcare accessible to the rural parts of India. Glocal is running 141 digital dispensaries across districts in +7 states which are mostly devoid of basic primary healthcare services. Some of its noticeable products include HellolyfCX (a portable digital clinic), LitmusMX (an IoT device for real time medical data acquisition and management though a centralised digital platform), LitmusDX (a clinical decision support system that provides end-to-end diagnostic and therapeutic tools to physicians), and LitmusRX (an electronically controlled medicine dispensing device).

CONSTRUCTION AND REAL ESTATE

India is soon projected to become the third largest construction market in the world. It has been one of the fastest growing markets over the past two decades,[36] and ambitious projects such as the ₹111 lakh crore National Infrastructure Pipeline will ensure India's position in the construction world.

In recent years, there have been several innovations in materials technology, construction and design techniques and building management software applications that have begun to find traction in the market. With the emergence of 3D printing technology, a California based start-up, Mighty Buildings is using it to build nearly zero waste, zero net energy, 3D printed homes from 350 to 1500sqft. In India, Tvasta unveiled India's first 3D printed home on the IIT Madras Campus. This technology could very well hold the key to quickly and efficiently building affordable housing in India.

During the COVID-19 pandemic, there has been a renewed focus on smart cities and the development of IT infrastructure. Tech enabled war rooms were quickly set up to enable the tracking of the virus' community spread. Governments in most countries launched contact tracing applications and telemedicine facilities. In China, it was shown that every 1 million yuan spent per 10,000 people on smart city infrastructure led to a decrease of 0.342 COVID-19 cases.[37]

In urban centre where smart construction sites are being adopted, Site management

Software is enabling contracting companies to more effectively manage construction schedules, supply chains and payments. GPS enabled tech is allowing companies to monitor the live locations of trucks and other shipments and adhere to delivery timelines.

IoT is another technology that is changing how construction sites function. IoT empowered remote control equipment is enabling construction progress in areas that are too dangerous for humans to access. IoT wearables are allowing site managers to keep track of safety and analyse data to help make sites safer. It is also making waste disposal more cost efficient and thus allowing companies to construct responsibly.

Globally, the Engineering and Construction (E&C) sector remains severely under-digitised. A stronger collaboration between Indian construction/infra heavyweights and the start-ups that are driving innovation in the sector, could have a huge impact on closing this digital gap.

36. https://www.pbctoday.co.uk/news/planning-construction-news/countries-investing-construction/54507/
37. https://pubmed.ncbi.nlm.nih.gov/33824851/

A. GLOBIZ

Structural health monitoring aims to extend the lifetime of new buildings and comfort of residents in cities. It incorporates condition monitoring, damage detection, and preventive maintenance processes into construction routine. The technology employs sensors, data acquisition, and analysis systems which help mitigate destruction risk.

The South Korea-based startup, Globiz, specialises in real-time integration of structural health monitoring. It monitors the status of buildings during and after construction. Globiz uses measurement sensors, diagnostic tools, and web-based control system for on-the-go status updates. The startup analyses and predicts the effects of abnormal structural load on buildings in cities.

B. INFRA.MARKET

The construction industry in India is fragmented into many small players falling under the unorganised sector. For higher growth, the multi-billion-dollar Indian construction industry needs to be streamlined.

The India-based startup, Infra.Market, provides a tech-enabled one-stop store for all categories of construction and related products. It functions as a marketplace that leverages technology to provide procurement experience for all players in the construction ecosystem. The startup is helping small businesses in the construction space improve the quality of their production and meet various compliances. Through its offering, it aspires to solve existing problems including lack of

price transparency, fragmented vendor base, unreliable quality, and inefficient logistics. Infra.Market has onboarded more than 170 small manufacturers, and some major construction and real estate companies such as giants Larsen & Toubro, Tata Projects and Ashoka Buildcon, as its clients.
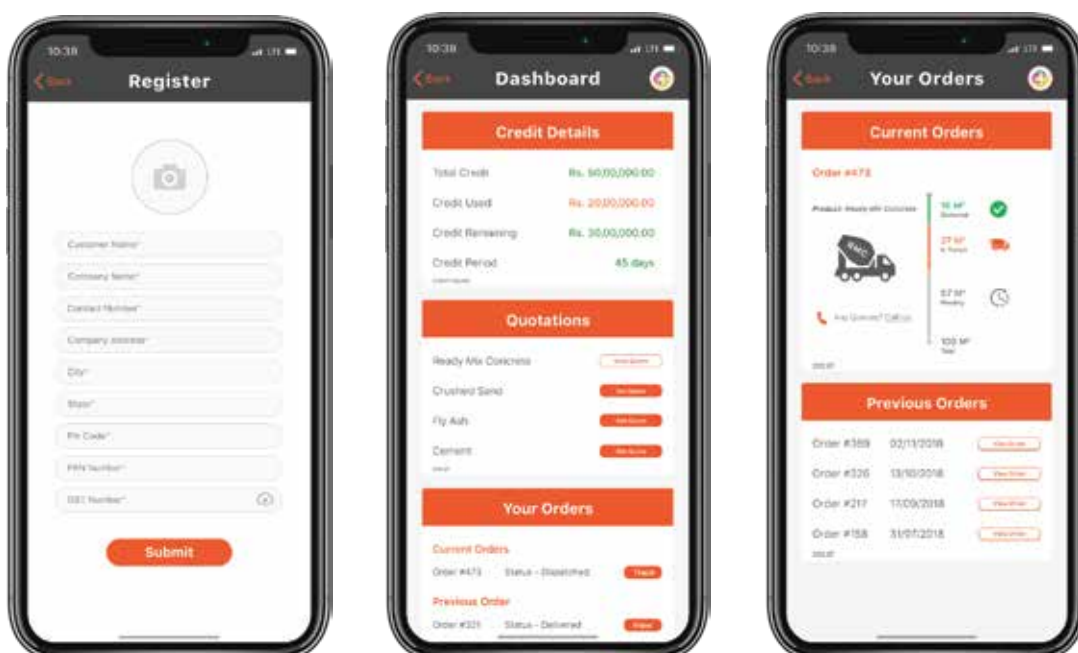
PART 3:
WAY FORWARD
AND VISION

India has been on a digital-first trajectory for a few years, spurred on by its goal of becoming a trillion-dollar digital economy by 2025. Availability of modern and facilitating infrastructure is a very important requirement for the growth of industry where the Government of India intends to develop industrial corridors and smart cities to provide infrastructure based on state-of-the-art technology with modern high-speed communication and integrated logistic arrangements. For any country, its infrastructure is a matter of pride. From roadways, railways to airports and other smart-city initiatives, the last few years have witnessed a phenomenal change in the sector, leading to world-class facilities coming up across various parts in the country. The infrastructure sector is the cornerstone of the Indian economy and has an important role to play in accelerating the country's overall development. The rapid rise of an educated middle class and demographic diversity in India offers enormous opportunities for the deployment of long-term capital for investment.

Terming investment in infrastructure quintessential to boost growth, the Economic Survey 2021, highlighted that infrastructure sectors are poised for growth post the pandemic crisis.[38] In the next decade, India will require huge private investments and overseas funding in this particular sector as cities become highly connected, districts located within cities become accessible and the urban-rural interconnectedness improves. The ambitious policies laid down by Finance Minister Nirmala Sitharaman in Union Budget 2021 will pave the way for India to attain its vision of becoming an inalienable nodal point in the global supply and value chains.

38. https://www.thehindu.com/business/economic-survey-2021-updates/article33694041.ece

The infrastructure sector has become the biggest focus area for the Government of India. India plans to spend USD 1.5 Trillion on infrastructure during FY 2020-2025 to have a sustainable development of the country. The Government has suggested investment of INR 5,000,000 Cr (USD 750 Bn) for railways infrastructure from 2018-30.[39] India and Japan have joined hands for infrastructure development in India's Northeast states and are also setting up an India-Japan Coordination Forum for Development of Northeast to undertake strategic infrastructure projects for the region. Such innovations combined with entrepreneurship can create tremendous overwhelming pathways for the nation. Fast-tracking of infrastructure development should therefore be seen as an important nation-building goal, and a sustained and well-coordinated push for adoption of world-class tools, techniques and technology is needed from the top to unshackle India's growth potential.

Industry 4.0 is well underway, and India is moving fast to unlock the potential of smart factories that connect people, processes and machines for better efficiency and enhanced output. The country's large talent pool is an asset that needs to be upskilled for the smart factory era. Innovation and research activities are being supported through a fast paced registration system and accordingly infrastructure of Intellectual Property Rights registration set-up has been upgraded. FDI has been opened up in Defence Production, Construction and Railway infrastructure in a big way. Initiatives like Make in India which had identified 25 sectors in manufacturing, infrastructure and service activities and detailed information being shared through

interactive web-portal opens pathways for future developments in Infrastructure.[40]

Technology Information, Forecasting and Assessment TIFAC Vision 2030 identifies how technology can be utilised under different sectors of the economy, streamlining the future of infrastructure development in India. Technology Development will require the foundation of networked institutions and infrastructures as a springboard for growth. The first and most essential infrastructure initiative must be the establishment of advanced manufacturing hubs tightly integrated with relevant knowledge institutions. Providing high speed connectivity through length and breadth of country by deploying ICT infrastructure and last mile connectivity in an affordable and competitive manner is imperative. Other infrastructure development, in areas such as airports, ports, highways, railways, pipelines, cold chains and dams, can lend crucial support with all the appropriate connectivity and forward and backward linkages, and are therefore essential.

39. https://www.ibef.org/industry/infrastructure-sector-india.aspx#:~:text=In%20the%20Union%20Budget%202020to%20develop%20the%20transport%20infrastructure.&text=50%2C040%20crore%20(US%24%206.85%20billion,the%20Union%20Budget%202020%2D21.
40. https://www.pmindia.gov.in/en/major_initiatives/make-in-india/

The introduction of information technology and single window clearance to make governance more efficient and effective were some of the other concrete steps taken by the Government to improve the environment of doing business while allowing Indian Start-ups to develop lucrative methods of restructuring models of innovation. Production Linked Incentive aiming to enhance exports, provide conducive manufacturing ecosystem, and make India an integral part of the global supply chain especially for the 10 sectors identified under the scheme. A well connected nation is a prerequisite to a well - served nation. Once the remotest of the Indian villagers are digitally connected through broadband and high speed internet, then delivery of electronic government services to every citizen, targeted social benefits, and financial inclusion can be achieved in reality. One of the key areas on which the vision of Digital India is centred is "digital infrastructure as a utility to every citizen".[41] E-governance in India has steadily evolved from computerization of Government Departments to initiatives that encapsulate the finer points of Governance, such as citizen centricity, service orientation and transparency. Hence, it offers to become a core utility for every citizen.

41. https://www.anilkakodkar.in/assignments/Technology-Vision-2035.pdf

STARTUPS FOR PUBLIC SERVICES

There are various ways to incorporate innovation in public service delivery to match the international trends and benchmarks to make India more efficient, competitive, and self-reliant. Public procurement is an essential component of national economic growth. It refers to acquisition by way of purchase, lease, license or otherwise, either using public funds or any other source of funds (e.g. grant, loans, gifts, private investment etc.) of goods, works or services or any combination thereof, including award of Public Private Partnership projects, by a Procuring Entity, whether directly or through an agency with which a contract for procurement services is entered into, but does not include any acquisition of goods, works or services without consideration, and the term 'procure' or 'procured' shall be construed accordingly.

In 2019, public procurement marked its importance by being 20-22 percent of the then GDP. The introduction of Government e-Marketplace (GeM), a national public procurement portal offering end to end solutions for all procurement needs of Central and State Government Departments, PSUs, autonomous institutions, and local bodies, entirely transformed the process for the Government buyers by providing them eased and transparent buying-techniques.

Thereupon, it was realised that the involvement of startups in public procurement would bring value addition to the public services and help the startups to reap the benefit of large-scale Government buying. To facilitate procurement from startups, the Department for Promotion of Industry and Internal Trade (DPIIT) has partnered with GeM. DPIIT recognised startups can now create a seller profile on GeM using: 1) the DPIIT Recognition Number, 2) Mobile number used for recognition, 3) PAN Number, and 4) Aadhar Number. Key policy changes were introduced to encourage public procurement opportunities for startups:

Exemptions - Startups are exempted from otherwise stringent selection criteria such as Prior Experience, Prior Turnover and Earnest Money Deposits

Pilot Projects - Startups get a chance to work on trial orders with the Government, making them more likely to take chances on a new product

Feedback Mechanism - Buyers can rate the startup product or service on GeM. Given the large scope of public procurement, this can help the startup to finetune and adapt the product for scale

Flexibility - There are no restrictive categories on GeM, meaning that new & innovative products can be published on the platform

Startup India (DPIIT) also provides case-to-case basis facilitation to startups for GeM onboarding, placement of products/ services, payments etc. Sensitization workshops are conducted for Central Ministries, Government Departments, State Governments, and startups on procurement through GeM.

As of May 2021, 9,755 DPIIT-recognised startups had received 73,340 orders with a total value of INR 3,237.6 Cr worth of products and services on GeM. This platform has enabled startups to get market access in the Government's horizons.

The Central Ministries and Government Departments can also procure products and services directly from startups through dedicated Innovation Challenges. These innovation challenges, also known as, 'Startup Grand Challenges', have channelized Government bodies to work with startups and incorporate the spirit of innovation and entrepreneurship. They help identify relevant, valuable solutions for the Departments' or Ministries' problem statements from the best innovators and startups in the country. These innovation challenges may be conducted in collaboration with Startup India (refer to Annexure 1 for more details).

ANNEXURE 1

STARTUP INDIA INNOVATION CHALLENGES
IN PARTNERSHIP WITH CENTRAL MINISTRIES AND DEPARTMENTS

Startup India has worked with various Central Ministries, Government Departments, and CPSUs, to conduct Innovation Challenges to promote competitiveness and engage entrepreneurs in supporting national endeavours undertaken by the Government. They help identify relevant, valuable solutions from the best innovators and startups in the country, leveraging the Ministry / Department's own industry networks and the Startup India Portal.

Startup India works with Central Ministries, Departments and CPSUs, to support startups across the following 4 Pillars:

Institutional Support
• Startup Policy for sectors, individual Government bodies, etc.
• Mechanism to support/adopt disruptive technologies
• Mechanism to provide mentorship to startups
• Mechanism to showcase startups
• Idea banks and technology transfer
• Regulatory Sandboxes

Infrastructure Support
• Incubation or Acceleration Programs
• Co-Working Spaces
• Setting up Research Laboratories / In-House Research and Development Facilities

Funding Support
• Setting up a dedicated fund for startups
• Cash grants through Grand Challenges
• Research funding for innovative projects

Public Procurement, Pilot Opportunities, and B2B Facilitation
• Exemption from prior experience, prior turnover criteria, and EMD
• Mechanism to provide pilot opportunities to relevant startups
• Mechanism to procure disruptive products and services
• Mechanism to facilitate B2B interactions between industry and startups

STARTUP GRAND CHALLENGE PROCESS

An innovation challenge is a globally acclaimed method of identifying relevant, innovative solutions to the critical problem areas identified by a Ministry / Department in their respective sector, and achieve following objectives:

• Leveraging technology and innovation for addressing challenges to enhance efficiency and productivity
• Identifying and solving for bottlenecks which prevent adoption of innovative products/ services
• Developing enabling mechanism for grooming ideas into effective pilots which translate into large-scale adoption through procurement
• Devising a framework for interaction with internal and external stakeholders that catalyse innovation

STARTUP GRAND CHALLENGE FLOW CHART

Finalization of Problem Statements and Incentives by Ministry / Dept.

▼

Launch of Applications on Startup India Portal

▼

Marketing: Outreach &Amplification

▼

Closing of Applications

▼

1st round of Screening of Applications

▼

Masterclasses for Shortlisted Applicants

▼

Expert External Committee Evaluation

▼

Top Startups Selected for Handholding and incentives

LIST OF INCENTIVES

An exhaustive list of the incentives that may be offered to the winning innovators/ startups of a Startup Grand Challenge is mentioned below, from which the Ministry / Department may choose their offerings.

Cash Prize
Top applicants from each problem statement for which the grand challenge has been launched, may be provided cash prizes worth at least INR 2 lakh each by the Ministry/ Department.

Seed Grant
Early-stage funding is challenging for innovators and startups, as Angel Investors and Venture Capital Funds consider investing at this stage to be very risky. It is not easy for the innovators to get business loans from financial institutions either. Therefore, the Ministry / Department may disburse seed grant up to INR 25 Lakh to early-stage startups selected in the ideation, validation, and commercialization phases to support development of their proof-of-concept and market entry. Through this grant, startups shall be able to graduate to a level where they can raise investments from angel investors or venture capital firms or seek loans from commercial banks or financial institutions.

41. The amounts mentioned are suggestive and the Ministry / Department may finalise on the actual amounts as per their respective budget.

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The grant shall be disbursed to the innovators and startups in milestone-based tranches. Timelines for milestones of the project shall be decided between the startup and the Ministry / Department after due-diligence approval. An Expert Evaluation Committee shall be set up for this purpose.

Incubation

Businesses need support to sustain or achieve scale on a great idea. There are many critical aspects spanning management, market strategy and regulatory support which young entrepreneurs may struggle with. Incubators ensure access to a panel of mentors who are dedicated experts invested in their success. They make access to investors easy and lend credibility to the startups and help open previously closed doors.

The Ministry / Department may consider supporting the creation of sector-focussed incubators in educational Institutes, or independently, or in PPP mode. There is shortage of technical and sector expertise in many incubators across India, which has hampered the growth of startups in those respective sectors. Alternately, existing incubators can be partnered with to build expertise in specific sectors and open incubation programs / ideation workshops for these areas of interest.

For sectors having adequate incubation infrastructure in place, the Ministry / Department may shortlist startups to help them build their product / solution with the help of an incubator. The incubator would be responsible for virtual / physical incubation of these startups for 9-12 months, where they would be provided with mentor matchmaking, lab facility for

Proof-of-Concept (PoC) development, testing facilities, business and investor workshops, and networking opportunities. The incubator shall be selected through an RFP process by Invest India.

Procurement & Pilot Opportunities

Government Departments are the biggest buyers in the country, and they possess great potential to work with startups for improving public service delivery. Startups are innovative, cost-effective, and indigenous in nature, and working with startups helps in getting easy access to technology and innovative solutions. Innovation Challenges offer a mechanism to identify the right startups that can add value to the functions of the Government.

Buyer-seller meets may be organized with all Central Departments, PSUs, and States to encourage them to procure from these startups and offer them pilot opportunities. This enables Government bodies to become aware about innovative solutions relevant to their mandates. A pilot project is a trial run, a small-scale version of a larger project, to understand the feasibility of implementation and potential problems of a specific good or service.

Upon completion of the pilot project, if the results are found to be satisfactory, startups shall be considered for large-scale deployment through procurement in the below manner:

1. Procurement through GeM

Selected startups shall be asked to register as sellers on Government e-Marketplace (GeM). States or any Government Department can place an order for up to INR 25,000 from these startups meeting the requisite quality, specification, and delivery period without having to compare the lowest price.

In addition to the above, a department may procure from the shortlisted startup for order between INR 25,000 to INR 5,00,000 through GeM by comparing the lowest price amongst the available sellers, of at least three different manufacturers, on GeM, meeting the requisite quality, specification, and delivery period.

2. Procurement through Tender

An open competitive tender shall be held to procure the relevant solution in volumes as required & found suitable by the Ministry / Department. Tendering enables the Ministry / Department to get a price comparison as per the requirement of GFR. The pre-qualification criteria and specifications shall be decided based on the solution provided by the selected startups. In cases, where due to the innovative nature of the solution, no other bids are received, the Ministry / Department can resort to Single tendering as per Rule 166 (i) (Proprietary Article Certificate).

3. Procurement by Corporate Entities

A prospective collaboration could be done with corporates in the sector, so that pilot and procurement opportunities could be provided to the shortlisted startups.

Apart from the above, it is also important for the Government to enable communication between industry and startups. Many corporates can benefit strategically by adopting the innovation developed by startups and this enables scaleup / partnerships opportunities for the entrepreneurs as well. Ministries can facilitate regular meetups between industry and relevant startups can enable such collaborations.

Other Institutional Support

For long-term growth of the respective sectors, the Ministry / Department may consider startup policies to drive innovation, disburse incentives, define regulations, enable procurement, etc.

Furthermore, publishing of known problem statements, ideation workshops, opening available technology in the sector for transfer to entrepreneurs for commercialization, etc. can drive more innovation in the sectors.

Regulatory sandboxes can also be considered by the Ministry / Department to enable experimental licenses, facilitating data-sharing and other sector-specific resources at affordable prices, simplifying and fast-track approvals for products and services for experimental purposes through de-licensing and other mechanisms.

ANNEXURE 2 : CASE STUDY ON ANIMAL HUSBANDRY STARTUP GRAND CHALLENGE

ABOUT THE PROGRAM

The Department of Animal Husbandry and Dairying, in partnership with Startup India, launched the 'Animal Husbandry Startup Grand Challenge', to scout for innovative and commercially viable solutions to address the problems faced by the animal husbandry and dairy sector. The challenge was launched by Hon'ble Prime Minister, Shri Narendra Modi, on 12th September 2019 at a national animal disease control programme in Mathura.

PROBLEM STATEMENTS

The challenge was open for application to all startups with unique solutions for six problem statements that were identified as below:

1. Value added products: introduce value added dairy products viz. cheese, smoothies, flavoured milk, custard, yoghurt, and other ethnic Indian products using innovative techniques for smaller domestic as well as export markets

2. Single use plastic alternatives: using environment-friendly alternatives to replace single-use polythene in dairy sector

3. Eliminate milk adulteration: tackling milk adulteration in the dairy sector

4. Breed improvement and animal nutrition: use of innovative technologies for quick genetic gain among Indian breeds of cattle and buffalos, and new varieties of green fodder and enriched animal feed

5. E-commerce solutions: encouraging innovations to provide modern digital infrastructure and advisory services across the country

6. Product traceability: using technologies to track the journey of dairy products from farm to fork

The challenge was open for application to startups from 12th of September 2019 to 30th of October 2019, on the Startup India portal – www.startupindia.gov.in.157 applications were received across the 6 problem statements.
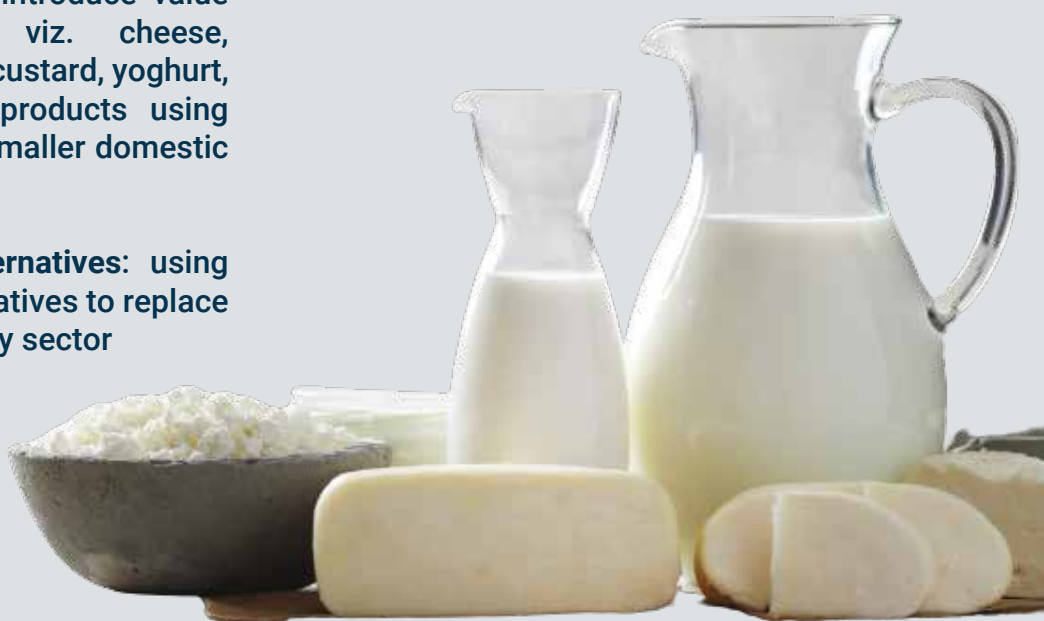
EVALUATION PROCESS

A three-stage evaluation process was followed for the applications received.

Stage 1:
The applications were pre-screened by the Startup India Team for DPIIT-recognition and other documents, to ensure that the information provided by the applicants fulfilled the criteria of application to the program.

Stage 2:
C-CAMP (Centre for Cellular and Molecular Platforms) was onboarded as an incubation partner, and a panel of experts evaluated the applications received on parameters such as the stage of the startup, novelty and scalability of the solution, and technology and business feasibility among others, to select 6 startups under each problem statement.

Stage 3:
A total of 42 startups were shortlisted for the third stage of evaluation. These startups were then given an opportunity to present their ideas over a video conference to an expert panel including members from the Department of Animal Husbandry and Dairying (DAHD) led by Shri Atul Chaturvedi, Secretary, Department of Animal Husbandry and Dairying. These video conferences were conducted in two days, where each selected startup showcased their solution followed by a round of questions and answers.

INCENTIVES

The Department of Animal Husbandry and Dairying provided innovative startups with solutions to the above-mentioned problem statements with the following:

1. **Cash Prizes**: Two winners under each problem statement were awarded with cash grants worth
   a. INR 10 Lakh (Winner)
   b. INR 7 Lakh (Runner-up)

2. **Mentorship**: 6 virtual masterclasses were conducted for providing mentorship to all the applicant startups

3. **Incubation Program**: 10 winning startups were provided incubation support for 9 months, which included mentor matchmaking, lab facility for POC development, testing facilities, business and investor workshops, and networking sessions. C-CAMP (Centre for Cellular and Molecular Platforms) was onboarded as an incubation partner after an RFP process by Invest India.